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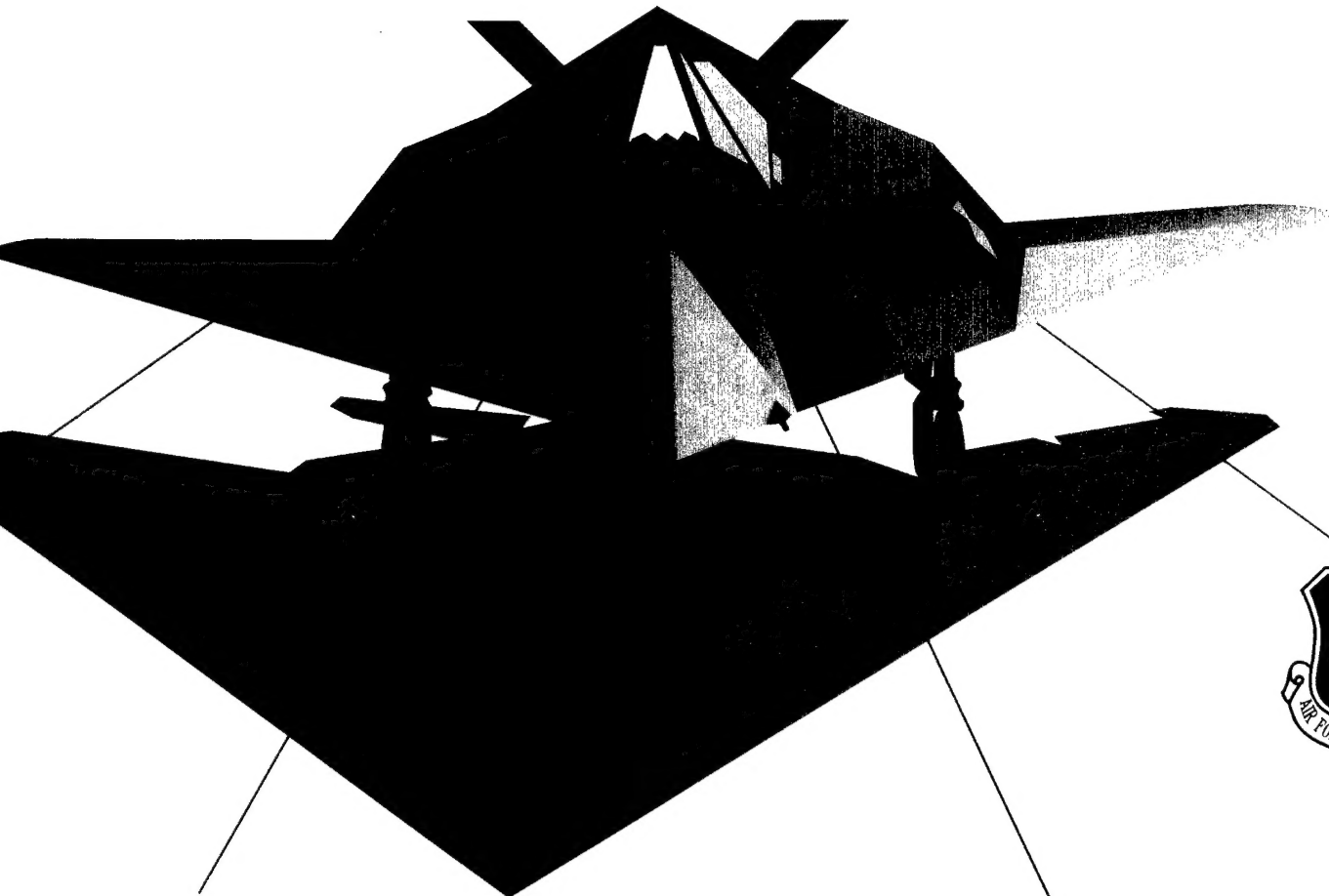


Photolytic Destruction Technology Technical Memorandum

Environmental Management of Offgas Technology

Site S, Operable Unit D

Delivery Order 7036



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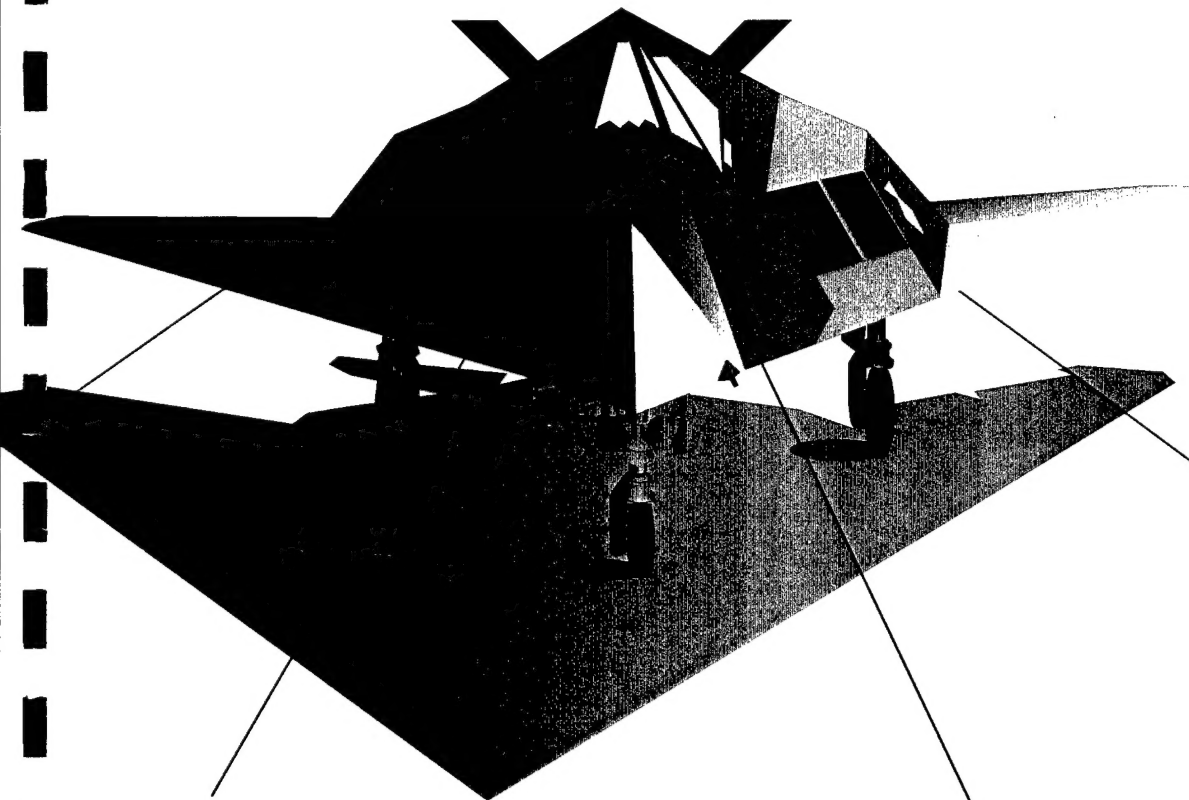


Photolytic Destruction Technology Technical Memorandum

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AQM01-03-0592

**Appendices for Final
Technology Demonstration Memorandum IIA
Photolytic Destruction Technology
Environmental Management of
Off-Gas Technology**

Prepared for

**McClellan Air Force Base
Contract No. F04699-93-D-0017**

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Prepared by



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July 1996

APPENDIX A

Site Description and Manifold Connection Details

The existing well configuration and piping layout are presented in Figures A-1 through A-3. Figure A-1 shows the SVE pumps and well manifold connections. Figure A-2 shows the Site S wells and their respective manifolds and connection points to the air-water separators, blowers, and downstream offgas treatment equipment.

From Figure A-2 it can be seen that all of the new wells (i.e., non-Site S wells) are manifolded together. This common header is connected to the manifold that receives the flow from all the deep wells from Site S. The combined flow from the new wells and Site S deep wells are routed through the larger air-water separator to the two 40-hp SVE vacuum pumps. The common headers for the deep and new systems are provided with valves to isolate the well systems from the suction of the vacuum pumps. During the demonstration, the Site S deep well manifold remained closed, thus eliminating any flow from these wells. Only the new well manifold remained open during the demonstration.

The effluent from the 50-hp and 40-hp vacuum pumps were manifolded [i.e., the overall transfer piping (OTP) header] and directed to the Catox and the PASS systems and finally discharged to the atmosphere. Note: The 50-hp pumps are typically used for extracting offgas from the pit and intermediate wells. However, the pump and well manifold connections allowed both the 40- and 50-hp systems to draw offgas from any of the wellheads. (These details are shown in Figure A-1).

Figure A-3 shows how the well connections from the non-site S wells tied into the Site S deep well manifolds.

Piping Modifications Made to the SVE System

The objective of the piping modifications was to extract the offgas slipstream from the manifold of the new well system in the most cost-effective manner. The technical challenges to the modifications were to maintain the desired temperature, flow, and pressure dynamics to the two innovative technologies in a consistent and safe manner. The economic challenges to the modification were to maximize the utilization of existing equipment such as the air-water separators, control equipment, and existing piping in order to minimize the cost impacts of the modifications.

Based on flow dynamics, simulation calculations, and the experience gained from previous demonstrations at Site S, it was decided to take a slipstream from downstream of the SVE vacuum pumps. To eliminate potential dilution of the gases in the OTP manifold, the slipstream was taken via a 2-inch coupling located approximately 1 foot from a 40-hp SVE vacuum pump discharge (but upstream of the OTP). A similar fitting was installed at a similar location on a redundant 40-hp vacuum pump to minimize downtime if the original blower required maintenance.

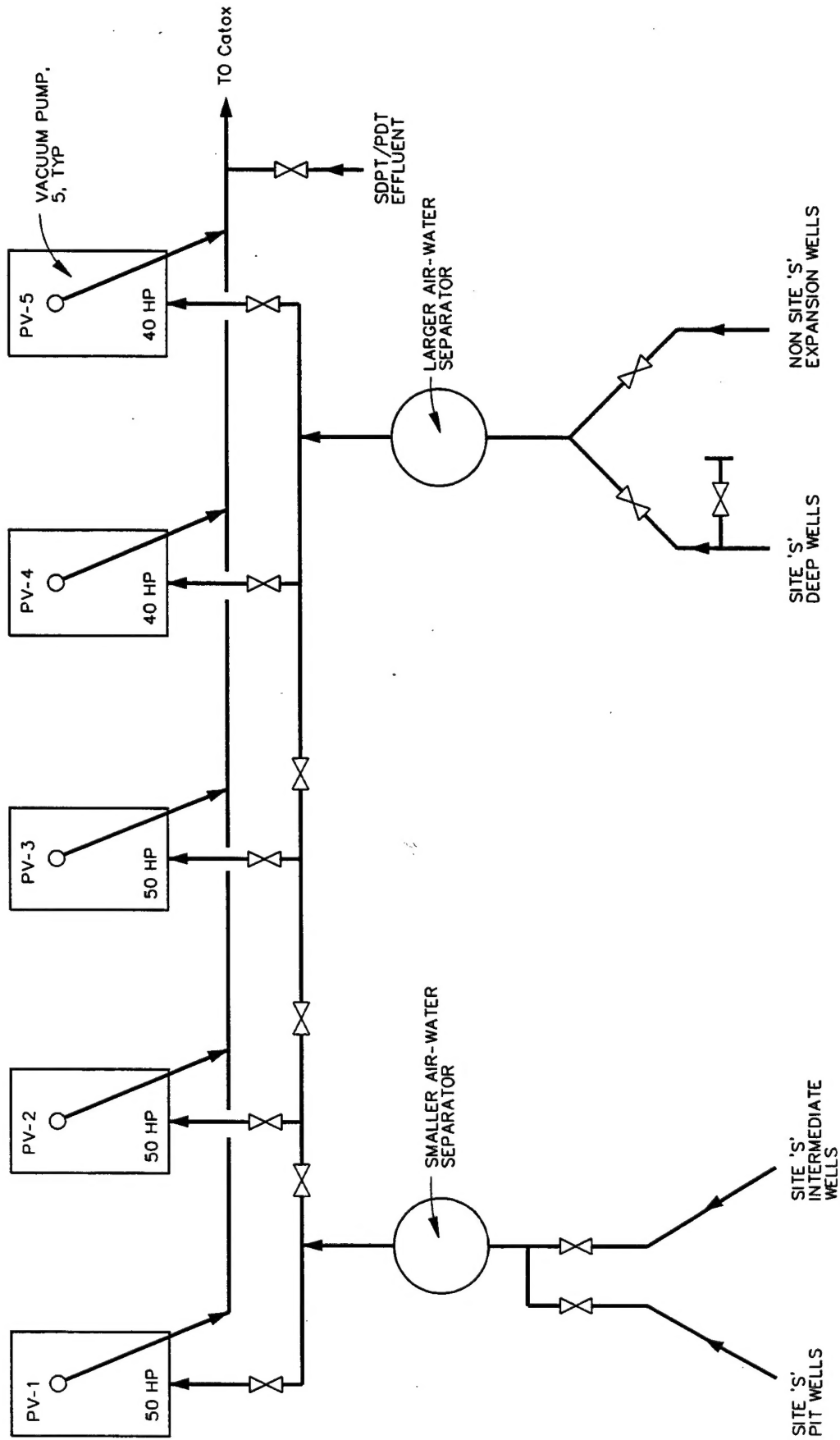
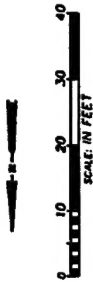
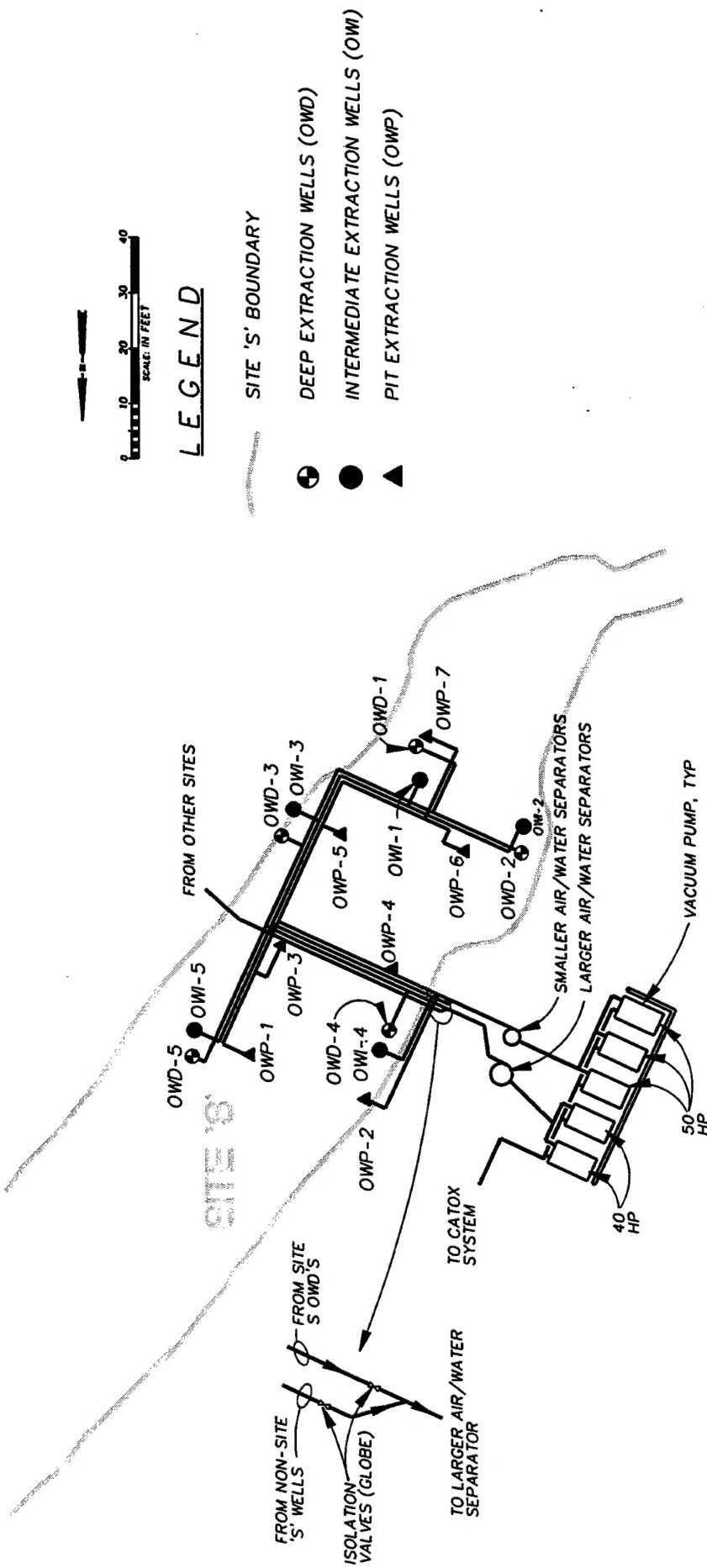


FIGURE A-1
SVE VACUUM PUMPS AND WELL
MANIFOLD CONNECTIONS



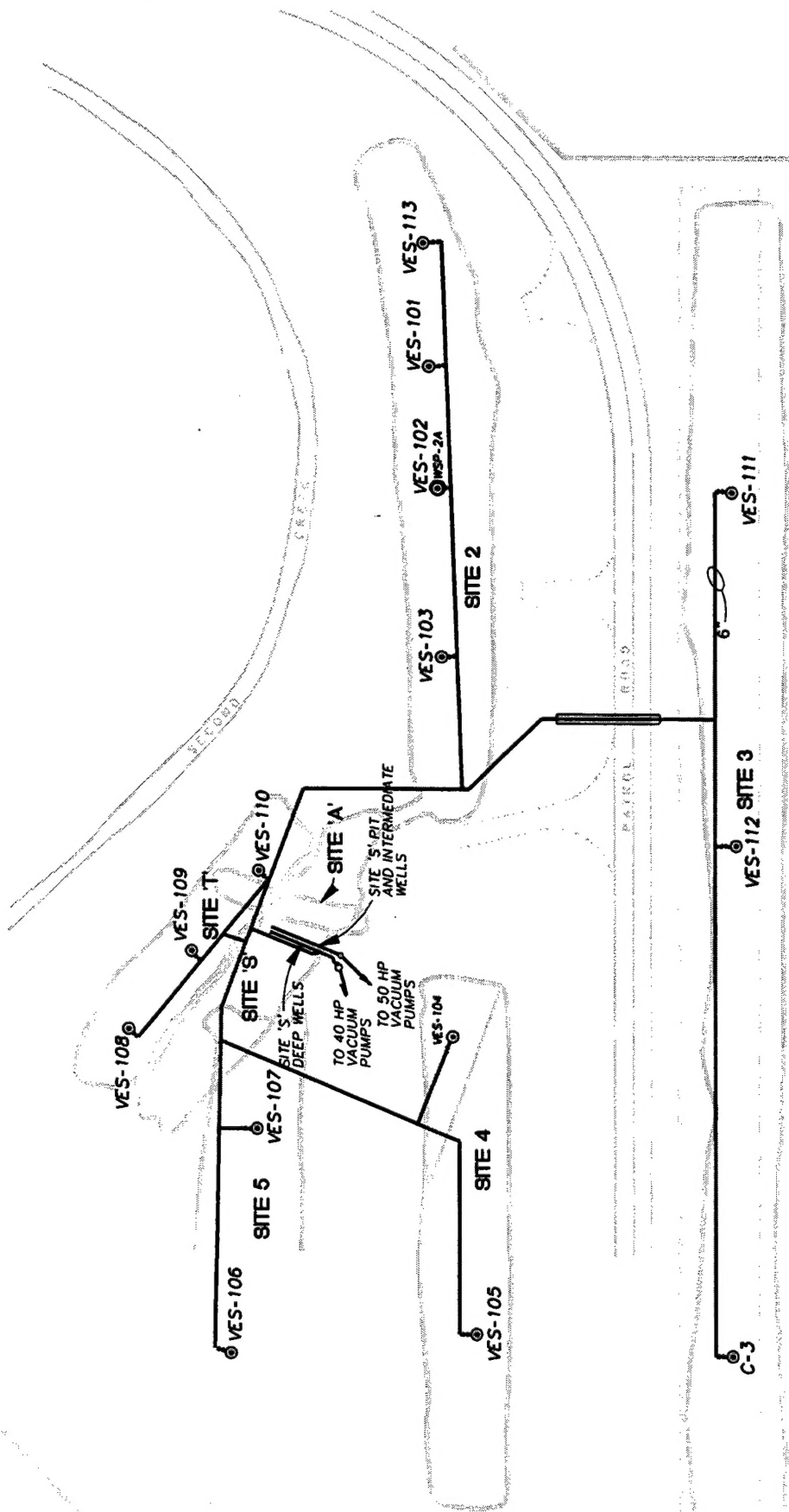


LEGEND

- SITE 'S' BOUNDARY
- ⊕ DEEP EXTRACTION WELLS (OWD)
- INTERMEDIATE EXTRACTION WELLS (OWI)
- ▲ PIT EXTRACTION WELLS (OWP)



FIGURE A-2
SITE 'S' EXTRACTION WELLS



SCALE: 1"=60'

- LEGEND**
- NEW EXTRACTION WELL
 - WASTE SITE BOUNDARY

**FIGURE A-3
NON SITE 'S'
EXTRACTION WELLS**

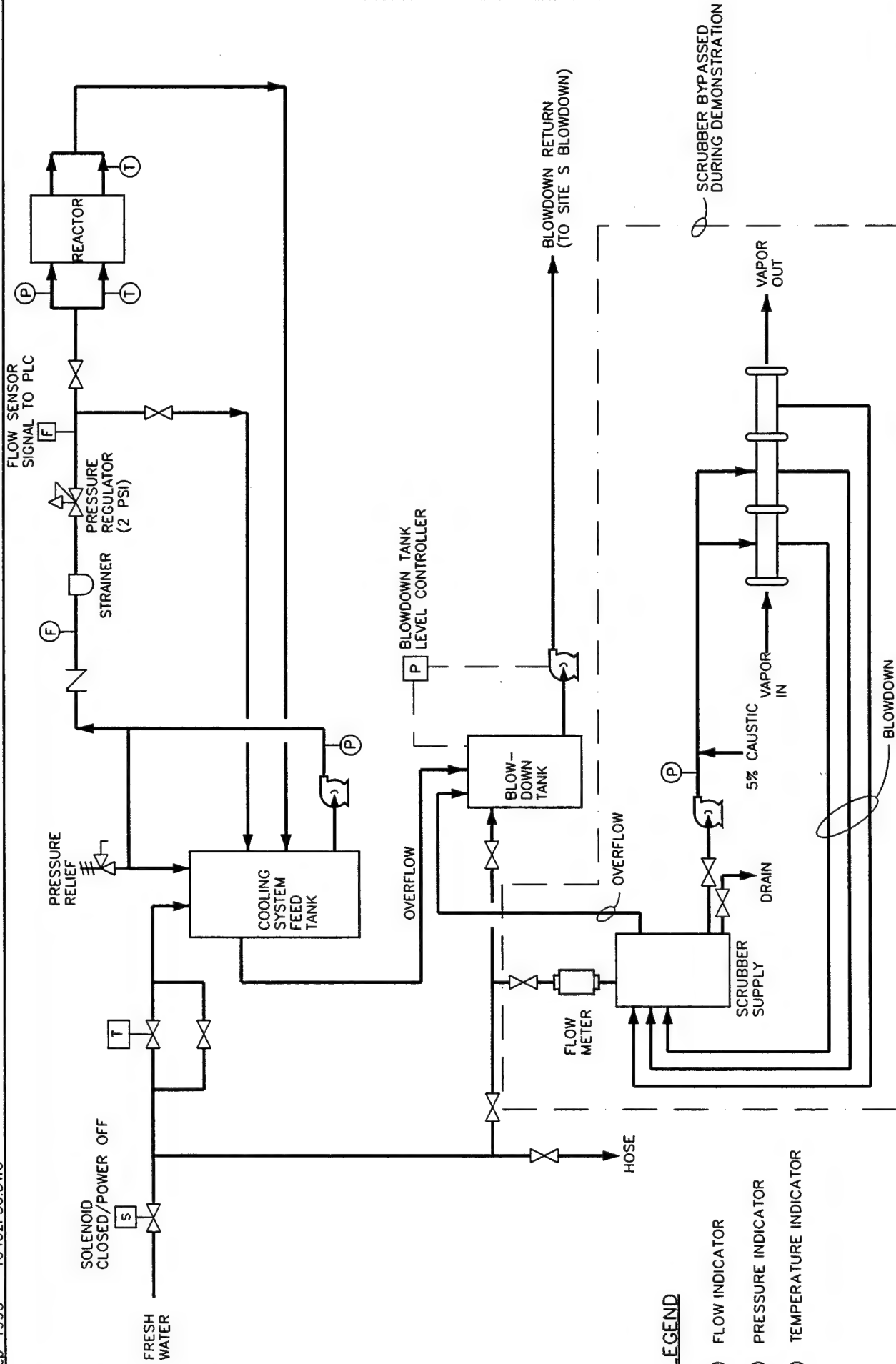


The piping connections into and out of the demonstration technology equipment are shown in Figure 3 in the main text. Initially, the slipstream was cooled from about 250°F to 100°F in a small air-to-water heat exchanger. The cooled stream was then routed through a Rotron® DR 513 regenerative blower (1.5 hp). Its discharge was split to feed the PDT equipment. The inlet offgas flow and pressure to the equipment were set manually by means of valves upstream of the equipment. The effluent from the demonstration equipment was routed back to the OTP manifold (downstream of the last vacuum pump tie-in to the OTP) and upstream of the flame arrester. A bypass line between upstream of the PDT influent line and the PDT effluent line was provided for flow and pressure equilibration and control. The bypass line was provided with a back-pressure regulator to maintain a positive pressure of 20 to 30 inches of water upstream of the innovative technology equipment. The bypass line was provided with a valve downstream of the innovative technology equipment to maintain a positive pressure of approximately 1 inch of water. Adequate check valves were provided in the pipes to eliminate cross-contamination or backflow problems. This arrangement eliminated the need for elaborate flow control devices, complicated piping, and the need for an additional air-water separator. Flow rates, temperatures, and pressures were verified prior to putting the PDT system online.

Location of Sample Ports

The influent gas sample port was located such that it is 5 pipe diameters from the discharge point of the smaller Rotron® blower and upstream of the PDT system boundaries. Effluent sampling ports were located 5 pipe diameters downstream of the reactor discharge points and 5 pipe diameters upstream of the nearest check valve.

The composite samples collected (COMOS and SOMOS) were collected from a sample port that manifolds together the following eight expansion wells: VES101, VES102, VES103, and VES113 from Site 2; VES104 and VES105 from Site 4; and VES106 and VES107 from Site 5.



LEGEND

- (F) FLOW INDICATOR
- (P) PRESSURE INDICATOR
- (T) TEMPERATURE INDICATOR

FIGURE B-1

PDT COOLING WATER SYSTEM

SITE S MCCLELLAN AFB
OCTOBER 1995
DRAWN BY A.T. DAVIS



Table C-1
Actual Sampling Schedule for Photolytic Destruction Technology

Parameter	Analytical Method	Inlet Samples										Outlet Samples									
		Week #										Week #									
		6-Nov	13-Nov	20-Nov	27-Nov	4-Dec	11-Dec	18-Dec	25-Dec	1-Jan	8-Jan	6-Nov	13-Nov	20-Nov	27-Nov	4-Dec	11-Dec	18-Dec	25-Dec	1-Jan	8-Jan
VOCs/GC	8010/8020	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	11
VOCs	TO-14	1	4*	2	2	2	2	2	0	1	2	1	3*	2	1	2	2	2	0	1	2
TNMOG	TO-12		2*	1	1	1	1	1	0	1	1		2*	1	1	1	1	1	0	1	1
Acetone	NIOSH 1300																				
02/CO2/CO	SM 2720C																				
SVOC	8270																				
Dioxin/Furan	1613A																				
Ozone	NIOSH S8																				
HCL/HF	300.0																				
NOX	300.0																				
Phosgene	Draeger Tubel																				
* Includes field duplicate sample.																					
Note: The number of equipment blank and field blank samples collected and analyzed are not included in this schedule.																					

Except for one GC sample and four Method TO-14 samples, all samples that were scheduled on Table SAP-2 in the Final Demonstration Work Plan Environmental Management of Offgas Technology were collected.

Detailed Experience During the Demonstration

Week 1 (Oct. 28, 1995, to Nov. 3, 1995)

The installation and verification of the safety features of the PDT system were completed on Monday, October 30. Well field gas was directed through the system on Wednesday, November 2. No liquid leaks were observed; however, traces of gas were detected near a PTI instrumentation panel. The gas lines to the panel were secured and operation began with temperatures, flows, and pressures as expected. Plenum leaks were first apparent on Wednesday, November 1; however, they were not considered a major concern. During week 1 the system treated process gas for a total of 4 hours.

Week 2 (Nov. 4, 1995, to Nov. 10, 1995)

Because of troubleshooting and plenum replacement efforts during week 2, operation was limited to 1 hour. To improve the PDT plenum design, PTI contacted several materials and manufacturing engineers. It was determined that internal pressure (as opposed to temperature changes) was the main cause of the plenum failures. Initial design work was begun, and a tentative repair schedule was prepared. The new plenums were expected to be completed by the week of November 20 and installed during the week of November 27.

Week 3 (Nov. 11, 1995, to Nov. 17, 1995)

During week 3, PTI personnel attempted to operate the PDT reactor with a limited number of cooling plenums. Under the circumstances, the system could not operate continuously. It ran a total of 13.5 hours.

Week 4 (Nov. 18, 1995, to Nov. 24, 1995)

On November 18, bench top pressure testing was successfully conducted on the newly constructed plenums. The plenum's final chemical resistant coatings were applied by November 22. The plenums arrived at the site on Sunday, November 26. The system was again operated under a modified schedule on November 20 and 21 of this week; the system treated process gas a total of 12 hours. On November 22 the reactor was shut down and dismantled in preparation for the arrival of the new plenums. The system remained out of service through the Thanksgiving holiday.

Week 5 (Nov. 25, 1995, to Dec. 1, 1995)

PTI reconstructed their system during week 5. On November 27 the new plenums were installed and pressure tested. On November 28 and 29 the lamps and liners were reinstalled and the lamps were rewired. Leak tests and initial startup procedures were completed on

the morning of November 30. Concerns regarding excess entrained water in the influent gas were addressed by installing a small air/water knockout pot ahead of the reactor inlet manifold, in week 6.

During startup, a large process gas pressure drop and flow restriction were observed across the reactor. Upon investigation it was found that several raisin-sized chunks of liner material were blocking the vapor effluent manifold of the reactor. This free liner material was probably deposited during the reinstallation of the liners following the plenum replacement. Once the material was removed, the pressure drop through the reactor returned to normal.

The system treated process gas on November 30 and December 1 of week 5 for a total of 31 hours.

Week 6 (Dec. 2, 1995, to Dec. 8, 1995)

PDT system uptime increased dramatically this week; the system ran a total of 159 hours. During week 6, PTI installed a small knockout pot ahead of their reactor in order to remove entrained liquid in the influent. It was also determined that the cooling water return pump was undersized, and this pump was replaced with a larger pump on December 4. Source testing for dioxin in PTI's effluent stream was completed on December 6.

Week 7 (Dec. 9, 1995, to Dec. 15, 1995)

During week 7, the PDT system again provided good operational runtime. The system was operated a total of 95.5 hours. A wind storm on December 12 and 13 of week 7 caused power outages and minor damage to the SVE system. Operations at the site were resumed by mid-day on December 14.

Week 8 (Dec. 16, 1995, to Dec. 22, 1995)

Aside from a 2-day shutdown (December 16 and 17), caused by the malfunction of a cooling water return pump control switch, the system ran well during week 8, for a total of 109 hours. The cooling water return switch was replaced on December 18 without incident.

Week 9 (Dec. 23, 1995, to Dec. 29, 1995)

Because of the holidays and replacement of the cementitious liners in the PDT reactor, significant downtime occurred during week 9. The system ran a total of 50.5 hours. As a precautionary measure, on December 26 and 27 the liners were replaced to ensure against breakthrough products, because it has been observed that breakthrough of certain VOCs can occur prior to the breakthrough of HCl.

Week 10 (Dec. 30, 1995 to January 5, 1996)

During week 10, downtime of the PDT reactor was caused by required downtime of the SVE system. The PDT system ran a total of 154 hours during week 10.

Week 11 (Jan. 6, 1996, to Jan. 12, 1996)

During week 11, as in week 10, downtime of the PDT reactor was caused by required downtime of the SVE system. The PDT system ran a total of 146 hours.

Week 12 (Jan. 13, 1996, to Jan. 19, 1996)

During week 12, the PDT system was demobilized and removed from the site. Table D-1 provides overall process parameters for the PDT system.

TABLE D-1
Process Parameters

Parameter	Range	Comments
Flow	10 to 15 cfm	Average flow rate was approximately 6.3 cfm
SVE offgas temperature	24 to 68°C	Temperature fluctuations were weather-related. Average was approximately 40°C (104°F)
SVE offgas relative humidity	95 to 100%	Estimate
Uptime	Variable	Uptime improved significantly towards the completion of the demonstration.

Appendix E

Summary of VOC and TNMOC DRE Results

Figures

- E-1 Average VOC DRE Results by Method TO-14
- E-2 Average VOC DRE Results by GC Method 8010/8020
- E-3 Average Influent VOC Concentrations by Method TO-14
- E-4 Average Influent VOC Concentrations by GC Method 8010/8020

Tables

- E-1 PDT DRE Method TO-14 Results Presented by Sample
- E-2 Summary of Total VOC PDT DRE Results by GCMS Method TO-14 Sorted by Sample
- E-3 PDT DRE GC Method 8010/8020 Results Presented by Sample
- E-4 Summary of Total VOC PDT DRE Results by GC Method 8010/8020 Sorted by Sample
- E-5 Total Nonmethane Organic Carbon (TNMOC) DRE Results for PDT

Figure E-1
Average Influent VOC Concentrations by Method TO-14

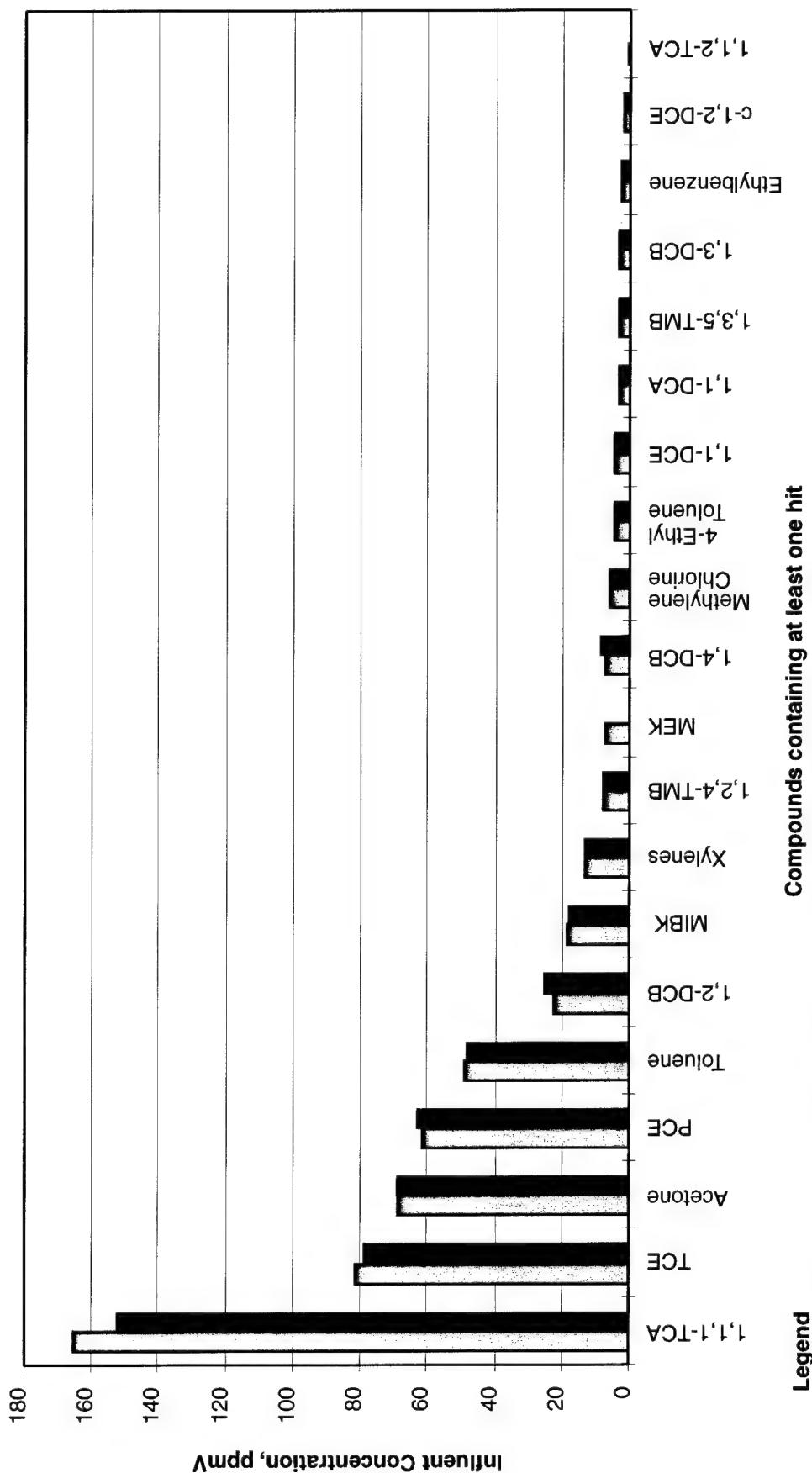
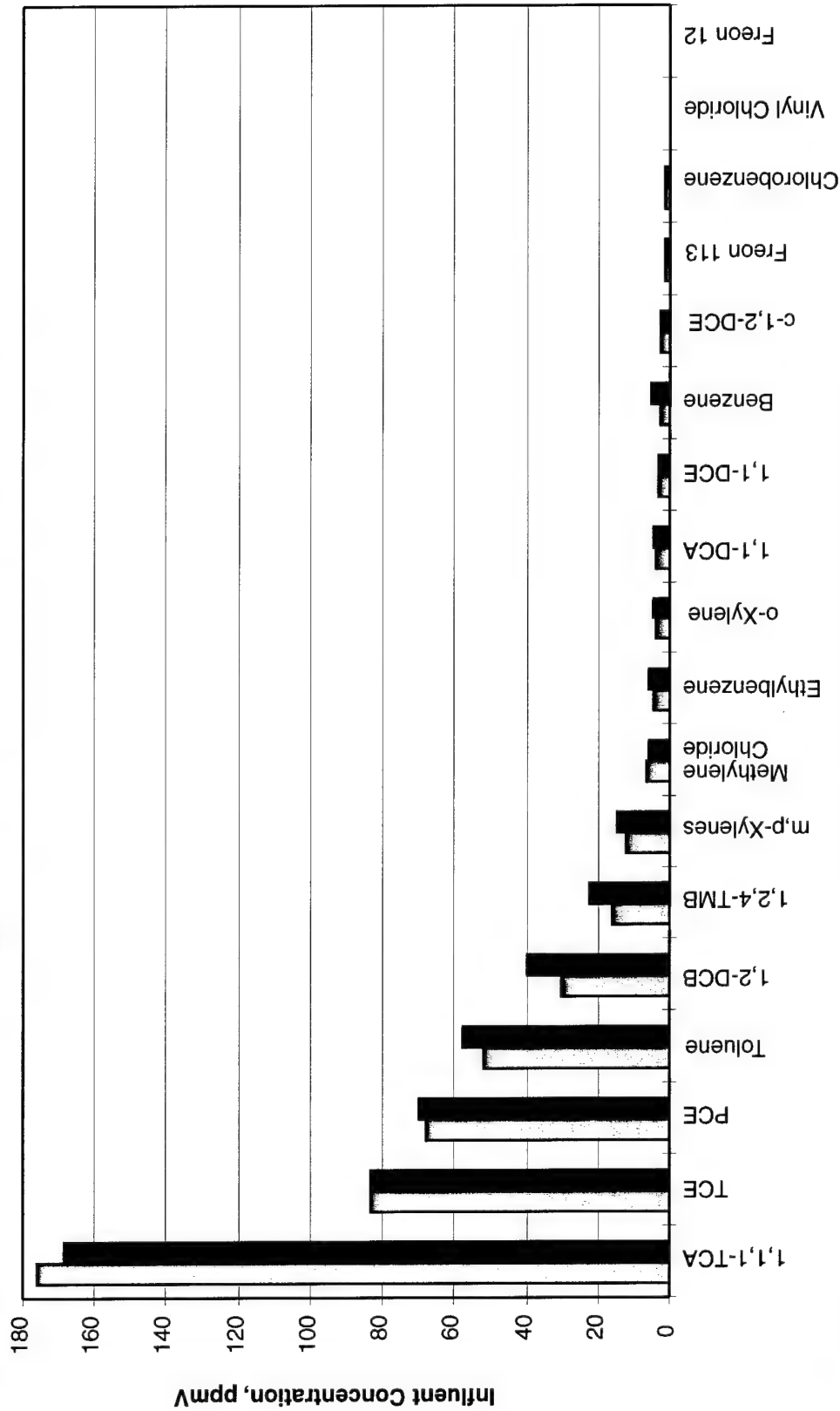


Figure E-2
Average Influent VOC Concentrations by GC Method 8010/8020

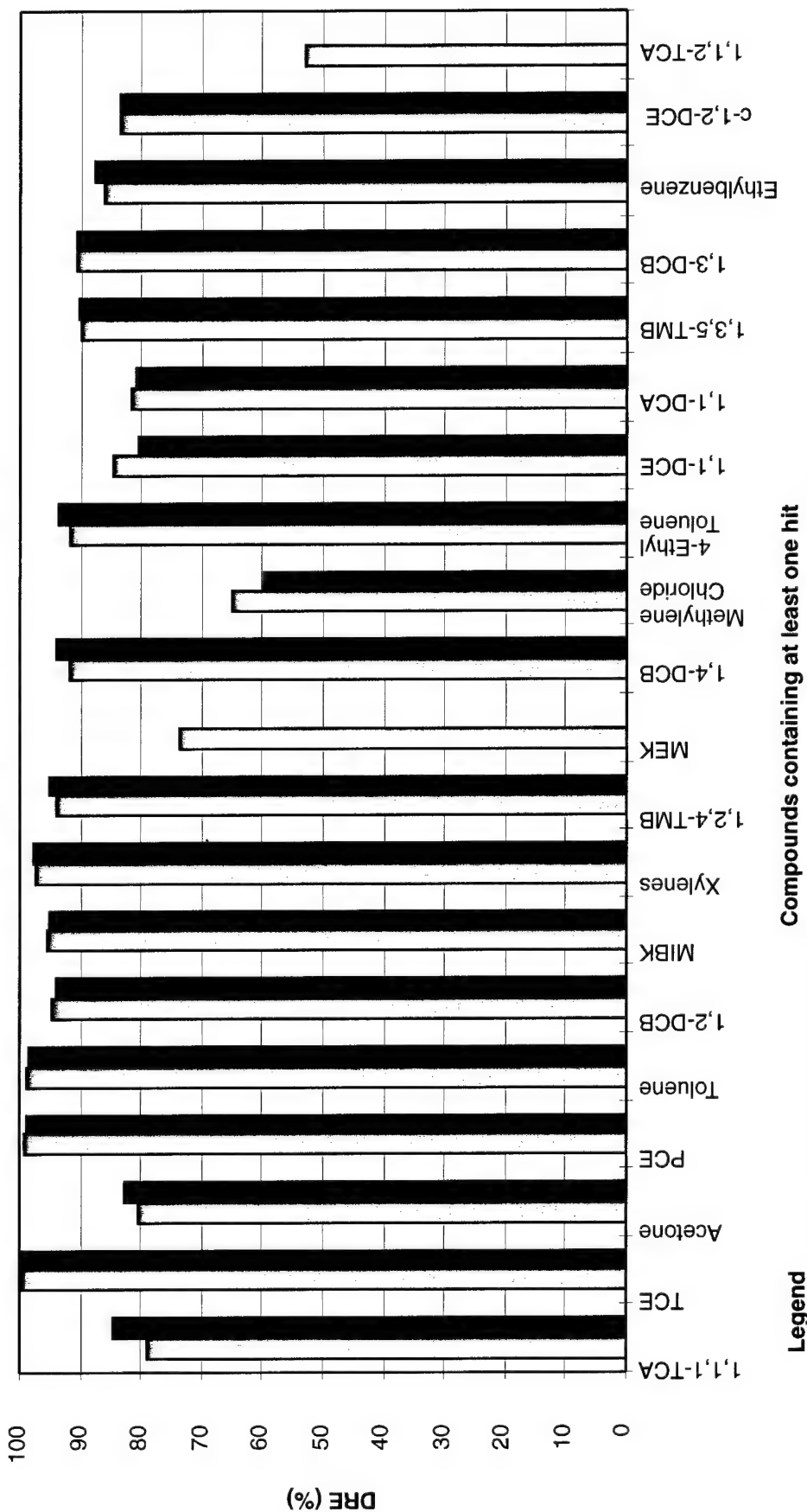


Compounds detected in at least one sample

Legend

- Average influent concentration for all samples collected (11/9/95 through 1/10/96)
- Average influent concentration for all samples collected after plenum replacement (12/6/95 through 1/10/96)

Figure E-3
Average VOC DRE Results by Method TO-14

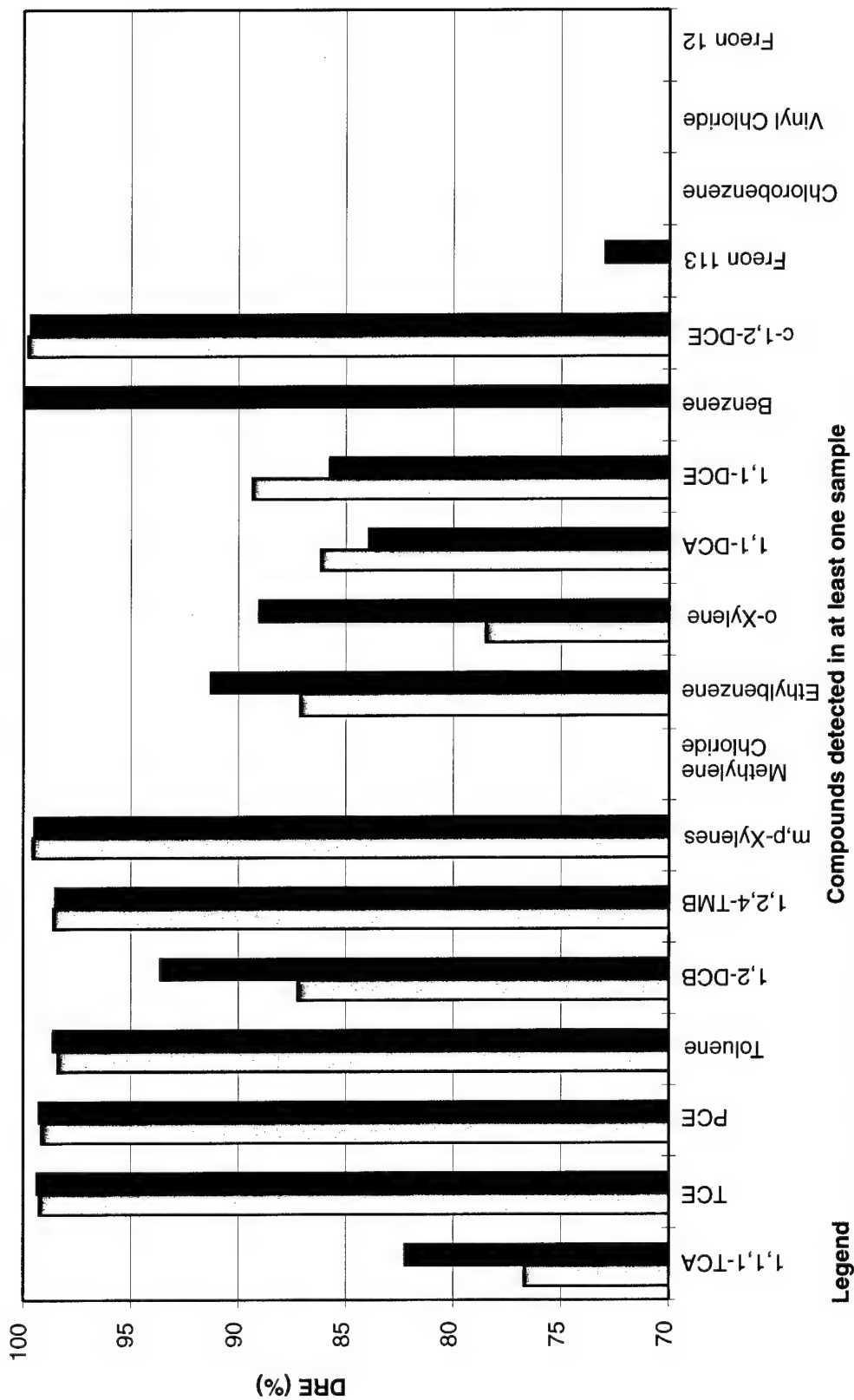


Legend

□ Overall average DRE for all samples collected between 11/14/95 and 1/10/96; >89.62%

■ Overall average DRE for samples collected after cooling plenum repair (12/7/95 through 1/10/96); >92.13%

Figure E-4
Average VOC DRE Results by GC Method 8010/8020



Legend

Compounds detected in at least one sample

- Overall average DRE for all samples collected between 11/9/95 and 1/10/96; >88.68%
- Overall average DRE for all samples collected after cooling plenum repair (12/6/95 through 1/10/96); >92.06%

Table E-1
PDT DRE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)	
C004	11/13/95	1,1,1-TRICHLOROETHANE	16	178.00	0.0593	83.50 U	0.0278	53.09
C004	11/13/95	1,1,2,2-TETRACHLOROETHANE	16	0.80 U		0.38 U		
C004	11/13/95	1,1,2-TRICHLOROETHANE	16	0.81	0.0003	0.38 U	0.0001	>52.84
C004	11/13/95	1,1-DICHLOROETHANE	16	3.69	0.0009	1.16	0.0003	68.56
C004	11/13/95	1,1-DICHLOROETHENE	16	3.96	0.0010	0.38 U	0.0001	>90.35
C004	11/13/95	1,2,4-TRICHLOROETHANE	16	1.59 U		0.76 U		
C004	11/13/95	1,2,4-TRIMETHYLBENZENE	16	5.32	0.0016	0.38 U	0.0001	>92.82
C004	11/13/95	1,2-DIBROMOETHANE	16	0.80 U		0.38 U		
C004	11/13/95	1,2-DICHLORO-TETRAFLUOROETHANE	16	0.80 U		0.38 U		
C004	11/13/95	1,2-DICHLOROBENZENE	16	9.10	0.0033	0.38 U	0.0001	>95.80
C004	11/13/95	1,2-DICHLOROETHANE	16	0.80 U		0.38 U		
C004	11/13/95	1,2-DICHLOROPROPANE	16	0.80 U		0.38 U		
C004	11/13/95	1,3,5-TRIMETHYLBENZENE	16	2.24	0.0007	0.38 U	0.0001	>82.95
C004	11/13/95	1,3-DICHLOROBENZENE	16	0.80 U		0.38 U		
C004	11/13/95	1,4-DICHLOROBENZENE	16	1.58	0.0006	0.38 U	0.0001	>75.82
C004	11/13/95	2-HEXANONE	16	1.59 U		0.76 U		
C004	11/13/95	4-ETHYL TOLUENE	16	3.50	0.0011	0.38 U	0.0001	>89.09
C004	11/13/95	ACETONE	16	60.10 U	0.0087	33.60 U	0.0049	44.09
C004	11/13/95	BENZENE	16	0.80 U		0.38 U		
C004	11/13/95	BENZYL CHLORIDE	16	3.90 UJ		0.38 UJ		
C004	11/13/95	BROMODICHLOROMETHANE	16	0.80 U		0.38 U		
C004	11/13/95	BROMOFORM	16	0.80 U		0.38 U		
C004	11/13/95	BROMOMETHANE	16	0.80 U		0.38 U		
C004	11/13/95	C-1,2-DICHLOROETHENE	16	2.27	0.0005	0.38 U	0.0001	>83.17
C004	11/13/95	CARBON DISULFIDE	16	3.99 U		1.91 U		
C004	11/13/95	CARBON TETRACHLORIDE	16	0.80 U		0.38 U		
C004	11/13/95	CHLOROBENZENE	16	0.80 U		0.38 U		
C004	11/13/95	CHLOROETHANE	16	1.59 U		0.76 U		
C004	11/13/95	CHLOROFORM	16	0.80 U	0.0002	1.95	0.0006	
C004	11/13/95	CHLOROMETHANE	16	1.59 U		0.76 U		
C004	11/13/95	CIS-1,3-DICHLOROPROPENE	16	0.80 U		0.38 U		
C004	11/13/95	DIBROMOCHLOROMETHANE	16	0.80 U		0.38 U		
C004	11/13/95	ETHYLBENZENE	16	2.35	0.0006	0.38 U	0.0001	>83.74
C004	11/13/95	FREON 11	16	0.80 U		0.38 U		
C004	11/13/95	FREON 113	16	0.80 U		0.38 U		
C004	11/13/95	FREON 12	16	0.80 U		0.38 U		
C004	11/13/95	HEXACHLOROBUTADIENE	16	1.59 UJ		0.76 UJ		
C004	11/13/95	METHYL ETHYL KETONE	16	7.27	0.0013	1.91 U	0.0003	>73.73
C004	11/13/95	METHYL ISOBUTYL KETONE	16	19.60	0.0049	0.76 U	0.0002	>96.10
C004	11/13/95	METHYLENE CHLORIDE	16	6.08	0.0008	3.03	0.0004	50.16
C004	11/13/95	STYRENE	16	0.80 U		0.38 U		

Table E-1
PDT DPE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)	
C004	11/13/95	TETRACHLOROETHENE	16	54.60	0.0226	0.53	0.0002	99.03
C004	11/13/95	TOLUENE	16	46.00	0.0106	0.38 U	0.0001	>99.17
C004	11/13/95	TRANS-1,2-DICHLOROETHENE	16	0.80 U		0.38 U		
C004	11/13/95	TRANS-1,3-DICHLOROPROPENE	16	0.80 U		0.38 U		
C004	11/13/95	TRICHLOROETHENE	16	80.50	0.0264	0.38 U	0.0001	>99.53
C004	11/13/95	VINYL ACETATE	16	3.99 U		1.91 U		
C004	11/13/95	VINYL CHLORIDE	16	0.80 U		0.38 U		
C004	11/13/95	XYLENES, TOTAL	16	11.30	0.0030	0.38 U	0.0001	>96.62
		Total		498.27	0.1483	123.77	0.0360	>75.70
C007	11/20/95	1,1,1-TRICHLOROETHANE	12	178.00	0.0445	56.90	0.0142	68.03
C007	11/20/95	1,1,2,2-TETRACHLOROETHANE	12	1.99 U		0.55 U		
C007	11/20/95	1,1,2-TRICHLOROETHANE	12	1.99 U		0.55 U		
C007	11/20/95	1,1-DICHLOROETHANE	12	3.75	0.0007	0.55 U	0.0001	>85.44
C007	11/20/95	1,1-DICHLOROETHENE	12	4.61	0.0008	0.55 U	0.0001	>88.16
C007	11/20/95	1,2,4-TRICHLOROBENZENE	12	3.99 UJ		1.09 UJ		
C007	11/20/95	1,2,4-TRIMETHYLBENZENE	12	3.88	0.0009	0.55 U	0.0001	>85.93
C007	11/20/95	1,2-DIBROMOETHANE	12	1.99 U		0.55 U		
C007	11/20/95	1,2-DICHLORO-TETRAFLUOROETHANE	12	1.99 UJ		0.55 UJ		
C007	11/20/95	1,2-DICHLOROBENZENE	12	8.21	0.0023	0.55 U	0.0002	>93.35
C007	11/20/95	1,2-DICHLOROETHANE	12	1.99 U		0.55 U		
C007	11/20/95	1,2-DICHLOROPROPANE	12	1.99 U		0.55 U		
C007	11/20/95	1,3,5-TRIMETHYLBENZENE	12	1.99 U		0.55 U		
C007	11/20/95	1,3-DICHLOROBENZENE	12	1.99 U		0.55 U		
C007	11/20/95	1,4-DICHLOROBENZENE	12	1.99 U		0.55 U		
C007	11/20/95	2-HEXANONE	12	3.99 U		1.09 U		
C007	11/20/95	4-ETHYL TOLUENE	12	2.69	0.0006	0.55 U	0.0001	>79.70
C007	11/20/95	ACETONE	12	61.70 U	0.0067	7.16 U	0.0008	88.40
C007	11/20/95	BENZENE	12	1.99 U		0.55 U		
C007	11/20/95	BENZYL CHLORIDE	12	1.99 UJ		0.55 UJ		
C007	11/20/95	BROMODICHLOROMETHANE	12	1.99 U		0.55 U		
C007	11/20/95	BROMOFORM	12	1.99 U		0.55 U		
C007	11/20/95	BROMOMETHANE	12	1.99 U		0.55 U		
C007	11/20/95	C-1,2-DICHLOROETHENE	12	1.99 U		0.55 U		
C007	11/20/95	CARBON DISULFIDE	12	9.96 U		2.73 U		
C007	11/20/95	CARBON TETRACHLORIDE	12	1.99 U		0.55 U		
C007	11/20/95	CHLOROBENZENE	12	1.99 U		0.55 U		
C007	11/20/95	CHLOROETHANE	12	3.99 U		1.09 U		
C007	11/20/95	CHLOROFORM	12	1.99 UJ	0.0004	3.35 U	0.0007	
C007	11/20/95	CHLOROMETHANE	12	3.99 U		1.09 U		
C007	11/20/95	CIS-1,3-DICHLOROPROPENE	12	1.99 U		0.55 U		

Table E-1
PDT DRE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet	
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)
C007	11/20/95	DIBROMOCHLOROMETHANE	12	1.99 U		0.55 U	
C007	11/20/95	ETHYLBENZENE	12	2.32	0.0005	0.55 U	0.0001
C007	11/20/95	FREON 11	12	1.99 U		0.55 U	
C007	11/20/95	FREON 113	12	1.99 U		0.55 U	
C007	11/20/95	FREON 12	12	1.99 U		0.55 U	
C007	11/20/95	HEXACHLOROBUTADIENE	12	3.99 UJ		1.09 UJ	
C007	11/20/95	METHYL ETHYL KETONE	12	9.96 U		2.73 U	
C007	11/20/95	METHYL ISOBUTYL KETONE	12	20.40	0.0038	1.09 U	0.0002
C007	11/20/95	METHYLENE CHLORIDE	12	7.79	0.0007	1.86	0.0002
C007	11/20/95	STYRENE	12	1.99 U		0.55 U	
C007	11/20/95	TETRACHLOROETHENE	12	61.10	0.0190	0.55 U	0.0002
C007	11/20/95	TOLUENE	12	49.00	0.0085	0.55 U	0.0001
C007	11/20/95	TRANS-1,2-DICHLOROETHENE	12	1.99 U		0.55 U	
C007	11/20/95	TRANS-1,3-DICHLOROPROPENE	12	1.99 U		0.55 U	
C007	11/20/95	TRICHLOROETHENE	12	80.40	0.0198	0.55 U	0.0001
C007	11/20/95	VINYL ACETATE	12	9.96 U		2.73 U	
C007	11/20/95	VINYL CHLORIDE	12	1.99 U		0.55 U	
C007	11/20/95	XYLENES, TOTAL	12	11.30	0.0022	0.55 U	0.0001
		Total		495.15	0.1113	69.27	0.0173
C010	11/30/95	1,1,1-TRICHLOROETHANE	10	204.00	0.0425	23.20	0.0048
C010	11/30/95	1,1,2,2-TETRACHLOROETHANE	10	1.96 U		0.23 U	
C010	11/30/95	1,1,2-TRICHLOROETHANE	10	1.96 U		0.23 U	
C010	11/30/95	1,1-DICHLOROETHANE	10	4.12	0.0006	0.23 U	0.00004
C010	11/30/95	1,1-DICHLOROETHENE	10	5.08	0.0008	0.23 U	0.00004
C010	11/30/95	1,2,4-TRICHLOROBENZENE	10	3.92 UJ		0.46 UJ	
C010	11/30/95	1,2,4-TRIMETHYLBENZENE	10	11.60	0.0022	0.23 U	0.00004
C010	11/30/95	1,2-DIBROMOETHANE	10	1.96 U		0.23 U	
C010	11/30/95	1,2-DICHLORO-TETRAFLUOROETHANE	10	1.96 U		0.23 U	
C010	11/30/95	1,2-DICHLOROBENZENE	10	37.40	0.0086	0.43	0.0001
C010	11/30/95	1,2-DICHLOROETHANE	10	1.96 U		0.23 U	
C010	11/30/95	1,2-DICHLOROPROPANE	10	1.96 U		0.23 U	
C010	11/30/95	1,3,5-TRIMETHYLBENZENE	10	4.01	0.0008	0.23 U	0.00004
C010	11/30/95	1,3-DICHLOROBENZENE	10	1.96 U		0.23 U	
C010	11/30/95	1,4-DICHLOROBENZENE	10	6.10	0.0014	0.23 U	0.0001
C010	11/30/95	2-HEXANONE	10	3.92 UJ		0.46 UJ	
C010	11/30/95	4-ETHYL TOLUENE	10	6.72	0.0013	0.23 U	0.00004
C010	11/30/95	ACETONE	10	82.90	0.0075	1.28	0.0001
C010	11/30/95	BENZENE	10	1.96 U		0.23 U	
C010	11/30/95	BENZYL CHLORIDE	10	1.96 U		0.23 U	
C010	11/30/95	BROMODICHLOROMETHANE	10	1.96 U		0.23 U	

Table E-1
PDT DPE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DPE (%)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)	
C010	11/30/95	BROMOFORM	10	1.96 U		0.23 U		
C010	11/30/95	BROMOMETHANE	10	1.96 U		0.23 U		
C010	11/30/95	C-1,2-DICHLOROETHENE	10	1.96 U		0.23 U		
C010	11/30/95	CARBON DISULFIDE	10	9.79 U		1.16 U		
C010	11/30/95	CARBON TETRACHLORIDE	10	1.96 U		0.23 U		
C010	11/30/95	CHLOROBENZENE	10	1.96 U		0.23 U		
C010	11/30/95	CHLOROETHANE	10	3.92 U		0.46 U		
C010	11/30/95	CHLOROFORM	10	1.96 U	0.0004	0.30	0.0001	
C010	11/30/95	CHLOROMETHANE	10	3.92 U		0.46 U		
C010	11/30/95	CIS-1,3-DICHLOROPROPENE	10	1.96 U		0.23 U		
C010	11/30/95	DIBROMOCHLOROMETHANE	10	1.96 U		0.23 U		
C010	11/30/95	ETHYLBENZENE	10	2.60	0.0004	0.23 U	0.00004	>91.08
C010	11/30/95	FREON 11	10	1.96 U		0.23 U		
C010	11/30/95	FREON 113	10	1.96 U	0.0006	0.24	0.0001	
C010	11/30/95	FREON 12	10	1.96 U		0.23 U		
C010	11/30/95	HEXACHLOROBUTADIENE	10	3.92 U		0.46 U		
C010	11/30/95	METHYL ETHYL KETONE	10	9.79 U		1.16 U		
C010	11/30/95	METHYL ISOBUTYL KETONE	10	21.10	0.0033	0.46 U	0.0001	>97.80
C010	11/30/95	METHYLENE CHLORIDE	10	6.03	0.0005	0.23 U	0.00002	>96.15
C010	11/30/95	STYRENE	10	1.96 U		0.23 U		
C010	11/30/95	TETRACHLOROETHENE	10	64.50	0.0167	0.23 U	0.0001	>99.64
C010	11/30/95	TOLUENE	10	53.30	0.0077	0.23 U	0.00003	>99.56
C010	11/30/95	TRANS-1,2-DICHLOROETHENE	10	1.96 U		0.23 U		
C010	11/30/95	TRANS-1,3-DICHLOROPROPENE	10	1.96 U		0.23 U		
C010	11/30/95	TRICHLOROETHENE	10	97.00	0.0199	0.23 U	0.00005	>99.76
C010	11/30/95	VINYL ACETATE	10	9.79 U		1.16 U		
C010	11/30/95	VINYL CHLORIDE	10	1.96 U		0.23 U		
C010	11/30/95	XYLENES, TOTAL	10	14.80	0.0025	0.23 U	0.00004	>98.43
		Total		621.26	0.1173	25.45	0.0057	>95.12
C012	12/7/95	1,1,1-TRICHLOROETHANE	10	143.00	0.0298	24.10	0.0050	83.15
C012	12/7/95	1,1,2,2-TETRACHLOROETHANE	10	1.85 U		0.37 U		
C012	12/7/95	1,1,2-TRICHLOROETHANE	10	1.85 U		0.37 U		
C012	12/7/95	1,1-DICHLOROETHANE	10	2.95	0.0005	0.95	0.0001	67.90
C012	12/7/95	1,1-DICHLOROETHENE	10	3.86	0.0006	1.47	0.0002	61.92
C012	12/7/95	1,2,4-TRICHLOROBENZENE	10	3.70 U		0.75 U		
C012	12/7/95	1,2,4-TRIMETHYLBENZENE	10	6.77	0.0013	0.37 U	0.0001	>94.48
C012	12/7/95	1,2-DIBROMOETHANE	10	1.85 U		0.37 U		
C012	12/7/95	1,2-DICHLORO-TETRAFLUOROETHANE	10	1.85 U		0.37 U		
C012	12/7/95	1,2-DICHLOROBENZENE	10	1.85 U	0.0004	1.09	0.0002	
C012	12/7/95	1,2-DICHLOROETHANE	10	1.85 U		0.37 U		

Table E-1
PDT DRE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)	
C012	12/7/95	1,2-DICHLOROPROPANE	10	1.85 U		0.37 U		
C012	12/7/95	1,3,5-TRIMETHYLBENZENE	10	2.69	0.0005	0.37 U	0.0001	>86.10
C012	12/7/95	1,3-DICHLOROBENZENE	10	3.47	0.0008	0.37 U	0.0001	>89.22
C012	12/7/95	1,4-DICHLOROBENZENE	10	21.50	0.0049	0.37 U	0.0001	>98.26
C012	12/7/95	2-HEXANONE	10	3.70 U		0.75 U		
C012	12/7/95	4-ETHYL TOLUENE	10	4.38	0.0008	0.37 U	0.0001	>91.46
C012	12/7/95	ACETONE	10	62.00	0.0056	19.20	0.0017	69.03
C012	12/7/95	BENZENE	10	1.85 U		0.37 U		
C012	12/7/95	BENZYL CHLORIDE	10	1.85 U		0.37 U		
C012	12/7/95	BROMODICHLOROMETHANE	10	1.85 U		0.37 U		
C012	12/7/95	BROMOFORM	10	1.85 U		0.37 U		
C012	12/7/95	BROMOMETHANE	10	1.85 U		0.37 U		
C012	12/7/95	C-1,2-DICHLOROETHENE	10	2.00	0.0003	0.37 U	0.0001	>81.30
C012	12/7/95	CARBON DISULFIDE	10	9.24 U		1.87 U		
C012	12/7/95	CARBON TETRACHLORIDE	10	1.85 U		0.37 U		
C012	12/7/95	CHLOROBENZENE	10	1.85 U		0.37 U		
C012	12/7/95	CHLOROETHANE	10	3.70 UJ		0.75 UJ		
C012	12/7/95	CHLOROFORM	10	1.85 U	0.0003	10.00	0.0019	
C012	12/7/95	CHLOROMETHANE	10	3.70 U	0.0003	2.59	0.0002	
C012	12/7/95	CIS-1,3-DICHLOROPROPENE	10	1.85 U		0.37 U		
C012	12/7/95	DIBROMOCHLOROMETHANE	10	1.85 U		0.37 U		
C012	12/7/95	ETHYLBENZENE	10	1.99	0.0003	0.37 U	0.0001	>81.21
C012	12/7/95	FREON 11	10	1.85 U		0.37 U		
C012	12/7/95	FREON 113	10	1.85 U		0.37 U		
C012	12/7/95	FREON 12	10	1.85 U		0.37 U		
C012	12/7/95	HEXACHLOROBUTADIENE	10	3.70 U		0.75 U		
C012	12/7/95	METHYL ETHYL KETONE	10	9.24 U		1.87 U		
C012	12/7/95	METHYL ISOBUTYL KETONE	10	13.60	0.0021	0.75 U	0.0001	>94.50
C012	12/7/95	METHYLENE CHLORIDE	10	4.84	0.0004	3.96	0.0003	18.18
C012	12/7/95	STYRENE	10	1.85 UJ		0.37 UJ		
C012	12/7/95	TETRACHLOROETHENE	10	47.60	0.0123	0.57	0.0001	98.81
C012	12/7/95	TOLUENE	10	45.30	0.0065	1.93	0.0003	95.74
C012	12/7/95	TRANS-1,2-DICHLOROETHENE	10	1.85 U		0.37 U		
C012	12/7/95	TRANS-1,3-DICHLOROPROPENE	10	1.85 U		0.37 U		
C012	12/7/95	TRICHLOROETHENE	10	77.00	0.0158	0.94	0.0002	98.78
C012	12/7/95	VINYL ACETATE	10	9.24 U		1.87 U		
C012	12/7/95	VINYL CHLORIDE	10	1.85 U		0.37 U		
C012	12/7/95	XYLENES, TOTAL	10	11.00	0.0018	0.37 U	0.0001	>96.60
		Total		453.95	0.0854	66.79	0.0110	>87.06
C014	12/14/95	1,1,1-TRICHLOROETHANE	12	148.00	0.0370	25.20	0.0063	82.97

Table E-1
PDT DPE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DPE (%)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)	
C014	12/14/95	1,1,2,2-TETRACHLOROETHANE	12	1.67 U		0.33 U		
C014	12/14/95	1,1,2-TRICHLOROETHANE	12	1.67 U		0.33 U		
C014	12/14/95	1,1-DICHLOROETHANE	12	3.73	0.0007	0.95	0.0002	74.64
C014	12/14/95	1,1-DICHLOROETHENE	12	4.48	0.0008	1.11	0.0002	75.22
C014	12/14/95	1,2,4-TRICHLOROBENZENE	12	3.33 U		0.65 U		
C014	12/14/95	1,2,4-TRIMETHYLBENZENE	12	8.56	0.0019	0.33 U	0.0001	>96.18
C014	12/14/95	1,2-DIBROMOETHANE	12	1.67 U		0.33 U		
C014	12/14/95	1,2-DICHLORO-TETRAFLUOROETHANE	12	1.67 UJ		0.33 UJ		
C014	12/14/95	1,2-DICHLOROBENZENE	12	26.90	0.0074	0.75	0.0002	97.22
C014	12/14/95	1,2-DICHLOROETHANE	12	1.67 U		0.33 U		
C014	12/14/95	1,2-DICHLOROPROPANE	12	1.67 U		0.33 U		
C014	12/14/95	1,3,5-TRIMETHYLBENZENE	12	3.42	0.0008	0.33 U	0.0001	>90.44
C014	12/14/95	1,3-DICHLOROBENZENE	12	5.23	0.0014	0.33 U	0.0001	>93.75
C014	12/14/95	1,4-DICHLOROBENZENE	12	4.90	0.0013	0.33 U	0.0001	>93.33
C014	12/14/95	2-HEXANONE	12	3.33 U		0.65 U		
C014	12/14/95	4-ETHYL TOLUENE	12	5.06	0.0011	0.33 U	0.0001	>93.54
C014	12/14/95	ACETONE	12	57.30 J	0.0062	8.59 U	0.0009	85.01
C014	12/14/95	BENZENE	12	1.67 U		0.33 U		
C014	12/14/95	BENZYL CHLORIDE	12	1.67 UJ		0.33 UJ		
C014	12/14/95	BROMODICHLOROMETHANE	12	1.67 U		0.33 U		
C014	12/14/95	BROMOFORM	12	1.67 U		0.33 U		
C014	12/14/95	BROMOMETHANE	12	1.67 U		0.33 U		
C014	12/14/95	C-1,2-DICHLOROETHENE	12	2.58 J	0.0005	0.33 UJ	0.0001	>87.33
C014	12/14/95	CARBON DISULFIDE	12	8.33 U		1.64 U		
C014	12/14/95	CARBON TETRACHLORIDE	12	1.67 U		0.33 U		
C014	12/14/95	CHLOROBENZENE	12	1.67 U		0.33 U		
C014	12/14/95	CHLOROETHANE	12	3.33 U		0.65 U		
C014	12/14/95	CHLOROFORM	12	1.67 U	0.0004	5.73	0.0013	
C014	12/14/95	CHLOROMETHANE	12	3.33 U	0.0003	1.31	0.0001	
C014	12/14/95	CIS-1,3-DICHLOROPROPENE	12	1.67 U		0.33 U		
C014	12/14/95	DIBROMOCHLOROMETHANE	12	1.67 U		0.33 U		
C014	12/14/95	ETHYLBENZENE	12	2.35	0.0005	0.33 U	0.0001	>86.09
C014	12/14/95	FREON 11	12	1.67 U		0.33 U		
C014	12/14/95	FREON 113	12	1.67 U		0.33 U		
C014	12/14/95	FREON 12	12	1.67 U		0.33 U		
C014	12/14/95	HEXACHLOROBUTADIENE	12	3.33 U		0.65 U		
C014	12/14/95	METHYL ETHYL KETONE	12	8.33 U		1.64 U		
C014	12/14/95	METHYL ISOBUTYL KETONE	12	18.10	0.0034	0.65 U	0.0001	>96.39
C014	12/14/95	METHYLENE CHLORIDE	12	5.48	0.0005	2.36	0.0002	56.93
C014	12/14/95	STYRENE	12	1.67 U		0.33 U		
C014	12/14/95	TETRACHLOROETHENE	12	52.40	0.0163	0.33 U	0.0001	>99.38

Table E-1
PDT DRE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)	DRE (%)
C014	12/14/95	TOLUENE	12	44.90	0.0077	0.33 U	0.0001	>99.27
C014	12/14/95	TRANS-1,2-DICHLOROETHENE	12	1.67 U		0.33 U		
C014	12/14/95	TRANS-1,3-DICHLOROPROPENE	12	1.67 U		0.33 U		
C014	12/14/95	TRICHLOROETHENE	12	76.50	0.0188	0.33 U	0.0001	>99.57
C014	12/14/95	VINYL ACETATE	12	8.33 U		1.64 U		
C014	12/14/95	VINYL CHLORIDE	12	1.67 U		0.33 U		
C014	12/14/95	XYLENES, TOTAL	12	12.60	0.0025	0.33 U	0.0001	>97.40
		Total		482.49	0.1096	45.99	0.0104	>90.52
C016	12/19/95	1,1,1-TRICHLOROETHANE	10	147.00	0.0306	28.40	0.0059	80.68
C016	12/19/95	1,1,2,2-TETRACHLOROETHANE	10	1.38 U		0.36 U		
C016	12/19/95	1,1,2-TRICHLOROETHANE	10	1.38 U		0.36 U		
C016	12/19/95	1,1-DICHLOROETHANE	10	3.70	0.0006	0.84	0.0001	77.22
C016	12/19/95	1,1-DICHLOROETHENE	10	3.77	0.0006	1.01	0.0002	73.21
C016	12/19/95	1,2,4-TRICHLOROBENZENE	10	2.77 U		0.72 U		
C016	12/19/95	1,2,4-TRIMETHYLBENZENE	10	10.20	0.0019	0.36 U	0.0001	>96.48
C016	12/19/95	1,2-DIBROMOETHANE	10	1.38 U		0.36 U		
C016	12/19/95	1,2-DICHLORO-TETRAFLUOROETHANE	10	1.38 U		0.36 U		
C016	12/19/95	1,2-DICHLOROBENZENE	10	35.60	0.0082	0.66	0.0002	98.16
C016	12/19/95	1,2-DICHLOROETHANE	10	1.38 U		0.36 U		
C016	12/19/95	1,2-DICHLOROPROPANE	10	1.38 U		0.36 U		
C016	12/19/95	1,3,5-TRIMETHYLBENZENE	10	4.03	0.0008	0.36 U	0.0001	>91.09
C016	12/19/95	1,3-DICHLOROBENZENE	10	2.36	0.0005	0.36 U	0.0001	>84.79
C016	12/19/95	1,4-DICHLOROBENZENE	10	6.61	0.0015	0.36 U	0.0001	>94.57
C016	12/19/95	2-HEXANONE	10	2.77 U		0.72 U		
C016	12/19/95	4-ETHYL TOLUENE	10	5.81	0.0011	0.36 U	0.0001	>93.82
C016	12/19/95	ACETONE	10	60.90 U	0.0055	20.70 U	0.0019	66.01
C016	12/19/95	BENZENE	10	1.38 U		0.36 U		
C016	12/19/95	BENZYL CHLORIDE	10	1.38 U		0.36 U		
C016	12/19/95	BROMODICHLOROMETHANE	10	1.38 U		0.36 U		
C016	12/19/95	BROMOFORM	10	1.38 U		0.36 U		
C016	12/19/95	BROMOMETHANE	10	1.38 U		0.36 U		
C016	12/19/95	C-1,2-DICHLOROETHENE	10	2.51	0.0004	0.36 U	0.0001	>85.70
C016	12/19/95	CARBON DISULFIDE	10	6.92 U		1.80 U		
C016	12/19/95	CARBON TETRACHLORIDE	10	1.38 U		0.36 U		
C016	12/19/95	CHLOROBENZENE	10	1.38 U		0.36 U		
C016	12/19/95	CHLOROETHANE	10	2.77 U		0.72 U		
C016	12/19/95	CHLOROFORM	10	1.38 U	0.0003	12.30	0.0023	
C016	12/19/95	CHLOROMETHANE	10	2.77 U	0.0002	2.06	0.0002	
C016	12/19/95	CIS-1,3-DICHLOROPROPENE	10	1.38 U		0.36 U		
C016	12/19/95	DIBROMOCHLOROMETHANE	10	1.38 U		0.36 U		

Table E-1
PDT DPE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)	DPE (%)
C016	12/19/95	ETHYLBENZENE	10	2.47	0.0004	0.36 U	0.0001	>85.47
C016	12/19/95	FREON 11	10	1.38 U		0.36 U		
C016	12/19/95	FREON 113	10	1.38 U		0.36 U		
C016	12/19/95	FREON 12	10	1.38 U		0.36 U		
C016	12/19/95	HEXACHLOROBUTADIENE	10	2.77 UJ		0.72 UJ		
C016	12/19/95	METHYL ETHYL KETONE	10	6.92 U		1.80 U		
C016	12/19/95	METHYL ISOBUTYL KETONE	10	19.50	0.0030	0.72 U	0.0001	>96.31
C016	12/19/95	METHYLENE CHLORIDE	10	5.49	0.0004	2.35	0.0002	57.19
C016	12/19/95	STYRENE	10	1.38 U		0.36 U		
C016	12/19/95	TETRACHLOROETHENE	10	55.00	0.0142	0.36 U	0.0001	>99.35
C016	12/19/95	TOLUENE	10	46.10	0.0066	0.36 U	0.0001	>99.22
C016	12/19/95	TRANS-1,2-DICHLOROETHENE	10	1.38 U		0.36 U		
C016	12/19/95	TRANS-1,3-DICHLOROPROPENE	10	1.38 UJ		0.36 UJ		
C016	12/19/95	TRICHLOROETHENE	10	76.00	0.0156	0.36 U	0.0001	>99.53
C016	12/19/95	VINYL ACETATE	10	6.92 U		1.80 U		
C016	12/19/95	VINYL CHLORIDE	10	1.38 U		0.36 U		
C016	12/19/95	XYLENES, TOTAL	10	14.1	0.0023	0.36 U	0.0001	>97.45
		Total		501.15	0.0947	68.32	0.0117	>87.62
C017	1/4/96	1,1,1-TRICHLOROETHANE	10.00	183	0.0381	29.8	0.0062	83.72
C017	1/4/96	1,1,2,2-TETRACHLOROETHANE	10.00	1.64 U		0.339 U		
C017	1/4/96	1,1,2-TRICHLOROETHANE	10.00	1.64 U		0.339 U		
C017	1/4/96	1,1-DICHLOROETHANE	10.00	3.57	0.0006	0.339 U	0.0001	>90.50
C017	1/4/96	1,1-DICHLOROETHENE	10.00	5.79	0.0009	0.339 U	0.0001	>94.15
C017	1/4/96	1,2,4-TRICHLOROBENZENE	10.00	3.27 U		0.679 U		
C017	1/4/96	1,2,4-TRIMETHYLBENZENE	10.00	6.46	0.0012	0.707	0.0001	89.06
C017	1/4/96	1,2-DIBROMOETHANE	10.00	1.64 U		0.339 U		
C017	1/4/96	1,2-DICHLORO-TETRAFLUOROETHANE	10.00	1.64 U		0.339 U		
C017	1/4/96	1,2-DICHLOROBENZENE	10.00	15	0.0034	2.41	0.0006	83.93
C017	1/4/96	1,2-DICHLOROETHANE	10.00	1.64 U		0.339 U		
C017	1/4/96	1,2-DICHLOROPROPANE	10.00	1.64 U		0.339 U		
C017	1/4/96	1,3,5-TRIMETHYLBENZENE	10.00	2.63	0.0005	0.339 U	0.0001	>87.11
C017	1/4/96	1,3-DICHLOROBENZENE	10.00	1.64 U		0.339 U		
C017	1/4/96	1,4-DICHLOROBENZENE	10.00	3.38	0.0008	0.46	0.0001	86.39
C017	1/4/96	2-HEXANONE	10.00	3.27 UJ		0.679 UJ		
C017	1/4/96	4-ETHYL TOLUENE	10.00	4.24	0.0008	0.339 U	0.0001	>92.00
C017	1/4/96	ACETONE	10.00	92	0.0083	2.77	0.0003	96.99
C017	1/4/96	BENZENE	10.00	1.64 U		0.339 U		
C017	1/4/96	BENZYL CHLORIDE	10.00	1.64 U		0.339 U		
C017	1/4/96	BROMODICHLOROMETHANE	10.00	1.64 U		0.339 U		
C017	1/4/96	BROMOFORM	10.00	1.64 U		0.339 U		

Table E-1
PDT DRE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)	
C017	1/4/96	BROMOMETHANE	10.00	1.64 U		0.339 U		
C017	1/4/96	C-1,2-DICHLOROETHENE	10.00	1.66	0.0003	0.339 U	0.0001	>79.58
C017	1/4/96	CARBON DISULFIDE	10.00	8.18 U		1.7 U		
C017	1/4/96	CARBON TETRACHLORIDE	10.00	1.64 U		0.339 U		
C017	1/4/96	CHLOROBENZENE	10.00	1.64 U		0.339 U		
C017	1/4/96	CHLOROETHANE	10.00	3.27 UJ		0.679 UJ		
C017	1/4/96	CHLOROFORM	10.00	1.64 U	0.0003	3.49	0.0006	
C017	1/4/96	CHLOROMETHANE	10.00	3.27 U		0.679 U		
C017	1/4/96	CIS-1,3-DICHLOROPROPENE	10.00	1.64 U		0.339 U		
C017	1/4/96	DIBROMOCHLOROMETHANE	10.00	1.64 U		0.339 U		
C017	1/4/96	ETHYLBENZENE	10.00	2.97	0.0005	0.339 U	0.0001	>88.59
C017	1/4/96	FREON 11	10.00	1.64 U		0.339 U		
C017	1/4/96	FREON 113	10.00	1.64 U		0.339 U		
C017	1/4/96	FREON 12	10.00	1.64 U		0.339 U		
C017	1/4/96	HEXACHLOROBUTADIENE	10.00	3.27 U		0.679 U		
C017	1/4/96	METHYL ETHYL KETONE	10.00	8.18 U		1.7 U		
C017	1/4/96	METHYL ISOBUTYL KETONE	10.00	21	0.0033	0.679 U	0.0001	>96.77
C017	1/4/96	METHYLENE CHLORIDE	10.00	7.78	0.0006	0.973	0.0001	87.49
C017	1/4/96	STYRENE	10.00	1.64 UJ		0.339 UJ		
C017	1/4/96	TETRACHLOROETHENE	10.00	89.1	0.0230	1.72	0.0004	98.07
C017	1/4/96	TOLUENE	10.00	59.7	0.0086	0.745	0.0001	98.75
C017	1/4/96	TRANS-1,2-DICHLOROETHENE	10.00	1.64 U		0.339 U		
C017	1/4/96	TRANS-1,3-DICHLOROPROPENE	10.00	1.64 U		0.339 U		
C017	1/4/96	TRICHLOROETHENE	10.00	93.6	0.0192	0.502	0.0001	99.46
C017	1/4/96	VINYL ACETATE	10.00	8.18 U		1.7 U		
C017	1/4/96	VINYL CHLORIDE	10.00	1.64 U		0.339 U		
C017	1/4/96	XYLENES, TOTAL	10.00	15.6	0.0026	0.399	0.0001	97.44
		Total		609.09	0.1129	41.17	0.0091	>91.91
C018	1/10/96	1,1,1-TRICHLOROETHANE	10.00	140	0.0291	10.2	0.0021	92.71
C018	1/10/96	1,1,2,2-TETRACHLOROETHANE	10.00	1.41 U		0.102 U		
C018	1/10/96	1,1,2-TRICHLOROETHANE	10.00	1.41 U		0.102 U		
C018	1/10/96	1,1-DICHLOROETHANE	10.00	2.99	0.0005	0.197	0.00003	93.41
C018	1/10/96	1,1-DICHLOROETHENE	10.00	4.76	0.0007	0.102 U	0.00002	>97.86
C018	1/10/96	1,2,4-TRICHLOROBENZENE	10.00	2.82 U		0.204 U		
C018	1/10/96	1,2,4-TRIMETHYLBENZENE	10.00	8.63	0.0016	0.135	0.00003	98.44
C018	1/10/96	1,2-DIBROMOETHANE	10.00	1.41 U		0.102 U		
C018	1/10/96	1,2-DICHLORO-TETRAFLUOROETHANE	10.00	1.41 U		0.102 U		
C018	1/10/96	1,2-DICHLOROBENZENE	10.00	23.5	0.0054	0.694	0.0002	97.05
C018	1/10/96	1,2-DICHLOROETHANE	10.00	1.41 U		0.102 U		
C018	1/10/96	1,2-DICHLOROPROPANE	10.00	1.41 U		0.102 U		

Table E-1
PDT DRE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)	
C018	1/10/96	1,3,5-TRIMETHYLBENZENE	10.00	3.43	0.0006	0.102	0.00002	>97.03
C018	1/10/96	1,3-DICHLOROBENZENE	10.00	1.76	0.0004	0.102	0.00002	>94.20
C018	1/10/96	1,4-DICHLOROBENZENE	10.00	5.05	0.0012	0.116	0.00003	97.70
C018	1/10/96	2-HEXANONE	10.00	2.82	U	0.204	U	
C018	1/10/96	4-ETHYL TOLUENE	10.00	5.04	0.0009	0.102	0.00002	>97.98
C018	1/10/96	ACETONE	10.00	72.3	0.0066	2.18	0.0002	96.98
C018	1/10/96	BENZENE	10.00	1.41	U	0.102	U	
C018	1/10/96	BENZYL CHLORIDE	10.00	1.41	U	0.102	U	
C018	1/10/96	BROMODICHLOROMETHANE	10.00	1.41	U	0.102	U	
C018	1/10/96	BROMOFORM	10.00	1.41	U	0.102	U	
C018	1/10/96	BROMOMETHANE	10.00	1.41	U	0.102	U	
C018	1/10/96	C-1,2-DICHLOROETHENE	10.00	1.41	U	0.102	U	
C018	1/10/96	CARBON DISULFIDE	10.00	7.05	U	0.509	U	
C018	1/10/96	CARBON TETRACHLORIDE	10.00	1.41	U	0.102	U	
C018	1/10/96	CHLOROBENZENE	10.00	1.41	U	0.102	U	
C018	1/10/96	CHLOROETHANE	10.00	2.82	U	0.204	U	
C018	1/10/96	CHLOROFORM	10.00	1.41	0.0003	3.86	0.0007	
C018	1/10/96	CHLOROMETHANE	10.00	2.82	0.0002	2.96	0.0002	
C018	1/10/96	CIS-1,3-DICHLOROPROPENE	10.00	1.41	U	0.102	U	
C018	1/10/96	DIBROMOCHLOROMETHANE	10.00	1.41	U	0.102	U	
C018	1/10/96	ETHYLBENZENE	10.00	2.45	0.0004	0.102	0.00002	>95.84
C018	1/10/96	FREON 11	10.00	1.41	U	0.102	U	
C018	1/10/96	FREON 113	10.00	1.41	0.0004	0.158	0.00005	
C018	1/10/96	FREON 12	10.00	1.41	UJ	0.102	UJ	
C018	1/10/96	HEXACHLOROBUTADIENE	10.00	2.82	U	0.204	U	
C018	1/10/96	METHYL ETHYL KETONE	10.00	7.05	U	0.509	U	
C018	1/10/96	METHYL ISOBUTYL KETONE	10.00	17.5	0.0027	1.4	0.0002	92.00
C018	1/10/96	METHYLENE CHLORIDE	10.00	5.19	0.0004	1.11	0.0001	78.61
C018	1/10/96	STYRENE	10.00	1.41	UJ	0.102	UJ	
C018	1/10/96	TETRACHLOROETHENE	10.00	69.9	0.0181	0.262	0.0001	99.63
C018	1/10/96	TOLUENE	10.00	46.1	0.0066	0.131	0.00002	99.72
C018	1/10/96	TRANS-1,2-DICHLOROETHENE	10.00	1.41	U	0.102	U	
C018	1/10/96	TRANS-1,3-DICHLOROPROPENE	10.00	1.41	U	0.102	U	
C018	1/10/96	TRICHLOROETHENE	10.00	70.9	0.0145	0.113	0.00002	99.84
C018	1/10/96	VINYL ACETATE	10.00	7.05	U	0.509	U	
C018	1/10/96	VINYL CHLORIDE	10.00	1.41	U	0.102	U	
C018	1/10/96	XYLENES, TOTAL	10.00	14.1	0.0023	0.102	0.00002	>99.28
		Total		495.01	0.0930	21.30	0.0041	>95.61
U - Compound was analyzed but not detected								
J - Estimated concentration								

Table E-1
PDT DRE Method TO-14 Results Presented by Sample

Sample	Date	Parameter	Inlet			Outlet		
			Flow (scfm)	Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)	DPE (%)
E - Concentration is above the linear range of the instrument								
D - Compound ran at a dilution to bring the concentration within the linear range of the instrument								

Table E-2

Summary of Total VOC PDT DRE Results by GCMS Method TO-14 Sorted by Sample

Date sampled	Inlet Mass Rate (lbs/hr)	Outlet Mass Rate (lbs/hr)	DRE (%)	Mass Removed (lbs/hr)
11/13/95	0.1481	0.0355	> 76.06	0.1126
11/20/95	0.1109	0.0166	> 85.05	0.0943
11/30/95	0.1164	0.0056	> 95.18	0.1108
12/7/95	0.0843	0.0087	> 89.64	0.0756
12/14/95	0.1089	0.0090	> 91.75	0.0999
12/19/95	0.0943	0.0093	> 90.16	0.0850
1/4/96	0.1126	0.0085	> 92.46	0.1041
1/10/96	0.0921	0.0031	> 96.65	0.0891
Average from 11/13/95 to 1/10/96	0.1084	0.0120	> 88.91	0.0964
Average from 12/7/95 to 1/10/96	0.0984	0.0077	> 92.16	0.0907

Notes:

An average DRE preceded by a greater than symbol (>) was calculated when a positive inlet concentration was reported with a nondetected outlet concentration.

Table E-3
PDT DRE GC Method 8010/8020 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)	Mass Removed (lbs/hr)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)		
C001	11/9/95	1,1,1-TRICHLOROETHANE	15	241.36	0.0753	132.40	0.0413	45.14	0.0340
C001	11/9/95	1,1-DICHLOROETHANE	15	4.57	0.0011	1.01	0.0002	77.96	0.0008
C001	11/9/95	1,1-DICHLOROETHENE	15	4.65	0.0011	0.11 J	0.00002	97.66	0.0010
C001	11/9/95	1,2,4-TRIMETHYLBENZENE	15	6.68	0.0019	0.13 U	0.00004	>98.13	0.0018
C001	11/9/95	1,2-DICHLOROBENZENE	15	6.22	0.0021	0.13 U	0.00004	>97.99	0.0021
C001	11/9/95	BENZENE	15	0.10 J	0.00002	0.07 J	0.00001	35.29	0.00001
C001	11/9/95	C-1,2-DICHLOROETHENE	15	3.25	0.0007	0.13 U	0.00003	>96.15	0.0007
C001	11/9/95	CHLOROBENZENE	15	0.92	0.0002	0.13 U	0.00003	>86.41	0.0002
C001	11/9/95	ETHYLBENZENE	15	4.12	0.0010	0.13 U	0.00003	>96.97	0.0010
C001	11/9/95	FREON 113	15	1.05	0.0003	0.62	0.0002	40.91	0.0001
C001	11/9/95	FREON 12	15	0.25 U		0.07 J	0.00002		
C001	11/9/95	M, P-XYLENES	15	9.57	0.0024	0.13 U	0.00003	>98.69	0.0023
C001	11/9/95	METHYLENE CHLORIDE	15	7.42	0.0009	2.94	0.0003	60.37	0.0005
C001	11/9/95	O-XYLENE	15	2.80	0.0007	0.13 U	0.00003	>95.54	0.0007
C001	11/9/95	TETRACHLOROETHENE	15	80.87	0.0314	0.57	0.0002	99.30	0.0312
C001	11/9/95	TOLUENE	15	56.10	0.0121	0.13 U	0.00003	>99.78	0.0121
C001	11/9/95	TRICHLOROETHENE	15	111.27	0.0342	0.15	0.00004	99.87	0.0341
C001	11/9/95	VINYL CHLORIDE	15	0.17 J	0.00003	0.13 U	0.00002	>26.90	0.00001
		Total		541.12	0.1655	137.92	0.0427	>74.19	0.1228
C003	11/13/95	1,1,1-TRICHLOROETHANE	15	210.06	0.0656	100.34	0.0313	52.23	0.0343
C003	11/13/95	1,1-DICHLOROETHANE	15	3.97 J	0.0009	2.50 U	0.0006	>37.00	0.0003
C003	11/13/95	1,1-DICHLOROETHENE	15	5.00 U		2.50 U			
C003	11/13/95	1,2,4-TRIMETHYLBENZENE	15	8.08	0.0023	2.50 U	0.0007	>69.05	0.0016
C003	11/13/95	1,2-DICHLOROBENZENE	15	7.57	0.0026	2.50 U	0.0009	>66.97	0.0017
C003	11/13/95	BENZENE	15	5.00 U		2.50 U			
C003	11/13/95	C-1,2-DICHLOROETHENE	15	2.64 J	0.0006	2.50 U	0.0006	>5.45	0.00003
C003	11/13/95	CHLOROBENZENE	15	5.00 U		2.50 U			
C003	11/13/95	ETHYLBENZENE	15	2.48 J	0.0006	2.50 U			
C003	11/13/95	FREON 113	15	5.00 U		2.50 U			
C003	11/13/95	FREON 12	15	5.00 U		2.50 U			
C003	11/13/95	M, P-XYLENES	15	9.21	0.0023	2.50 U	0.0006	>72.87	0.0017
C003	11/13/95	METHYLENE CHLORIDE	15	6.79	0.0008	2.29 J	0.0003	66.32	0.0005
C003	11/13/95	O-XYLENE	15	2.88 J	0.0007	2.50 U	0.0006	>13.28	0.0001
C003	11/13/95	TETRACHLOROETHENE	15	68.11	0.0264	1.35 J	0.0005	98.02	0.0259
C003	11/13/95	TOLUENE	15	46.50	0.0100	2.50 U	0.0005	>94.62	0.0095
C003	11/13/95	TRICHLOROETHENE	15	93.40	0.0287	2.50 U	0.0008	>97.32	0.0279
C003	11/13/95	VINYL CHLORIDE	15	5.00 U		2.50 U			
		Total		461.70	0.1415	103.97	0.0374	>73.60	0.1042
C005	11/15/95	1,1,1-TRICHLOROETHANE	10	162.97		21.27		86.95	0.0295

Table E-3
PDT DRE GC Method 8010/8020 Results Presented by Sample

Sample	Date	Parameter	Inlet			Outlet			DRE (%)	Mass Removed (lbs/hr)
			Flow (scfm)	Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)			
C005	11/15/95	1,1-DICHLOROETHANE	10	5.00 U		0.50 U				
C005	11/15/95	1,1-DICHLOROETHANE	10	5.00 U		0.50 U				
C005	11/15/95	1,2,4-TRIMETHYLBENZENE	10	1.04 J	0.0002	0.50 U	0.0001	>52.13		0.0001
C005	11/15/95	1,2-DICHLOROETHANE	10	5.00 U		0.50 U				
C005	11/15/95	BENZENE	10	5.00 U		0.50 U				
C005	11/15/95	C-1,2-DICHLOROETHANE	10	5.00 U		0.50 U				
C005	11/15/95	CHLOROBENZENE	10	5.00 U		0.50 U				
C005	11/15/95	ETHYLBENZENE	10	5.00 U		0.50 U				
C005	11/15/95	FREON 113	10	5.00 U		0.50 U				
C005	11/15/95	FREON 12	10	5.00 U		0.50 U				
C005	11/15/95	M, P-XYLENES	10	4.18 J	0.0007	0.50 U	0.0001	>88.04		0.0006
C005	11/15/95	METHYLENE CHLORIDE	10	6.66	0.0005	0.50 U	0.00004	>92.50		0.0005
C005	11/15/95	O-XYLENE	10	5.00 U		0.50 U				
C005	11/15/95	TETRACHLOROETHANE	10	65.33	0.0169	0.50 U	0.0001	>99.23		0.0168
C005	11/15/95	TOLUENE	10	31.17	0.0045	0.50 U	0.0001	>98.40		0.0044
C005	11/15/95	TRICHLOROETHANE	10	61.69	0.0126	0.50 U	0.0001	>99.19		0.0125
C005	11/15/95	VINYL CHLORIDE	10	5.00 U		0.50 U				
		Total		333.04	0.0693	21.27	0.0049	>92.87		0.0644
C007	11/20/95	1,1,1-TRICHLOROETHANE	12	158.02	0.0395	50.31 E	0.0126	68.16		0.0269
C007	11/20/95	1,1-DICHLOROETHANE	12	2.95 J	0.0005	0.96 U	0.0002	>67.66		0.0004
C007	11/20/95	1,1-DICHLOROETHANE	12	2.77 J	0.0005	0.96 U	0.0002	>65.47		0.0003
C007	11/20/95	1,2,4-TRIMETHYLBENZENE	12	1.79 J	0.0004	0.96 U	0.0002	>46.71		0.0002
C007	11/20/95	1,2-DICHLOROETHANE	12	1.24 J	0.0003	0.96 U	0.0003	>22.67		0.0001
C007	11/20/95	BENZENE	12	3.99 U		0.96 U				
C007	11/20/95	C-1,2-DICHLOROETHANE	12	1.97 J	0.0004	0.96 U	0.0002	>51.52		0.0002
C007	11/20/95	CHLOROBENZENE	12	3.99 U		0.96 U				
C007	11/20/95	ETHYLBENZENE	12	1.59 J	0.0003	0.96 U	0.0002	>40.09		0.0001
C007	11/20/95	FREON 113	12	3.99 U		0.32 J	0.0001			
C007	11/20/95	FREON 12	12	3.99 U		0.96 U				
C007	11/20/95	M, P-XYLENES	12	4.91	0.0010	0.96 U	0.0002	>80.53		0.0008
C007	11/20/95	METHYLENE CHLORIDE	12	5.60	0.0005	1.43	0.0001	74.41		0.0004
C007	11/20/95	O-XYLENE	12	1.19 J	0.0002	0.96 U	0.0002	>19.61		0.00005
C007	11/20/95	TETRACHLOROETHANE	12	49.51	0.0154	0.26 J	0.0001	99.47		0.0153
C007	11/20/95	TOLUENE	12	33.76	0.0058	0.96 U	0.0002	>97.17		0.0057
C007	11/20/95	TRICHLOROETHANE	12	67.54	0.0166	0.96 U	0.0002	>98.59		0.0164
C007	11/20/95	VINYL CHLORIDE	12	3.99 U		0.96 U				
		Total		332.82	0.0815	52.32	0.0148	>81.79		0.0666
C008	11/21/95	1,1,1-TRICHLOROETHANE	10	169.25	0.0352	48.78	0.0102	71.18		0.0251
C008	11/21/95	1,1-DICHLOROETHANE	10	2.90 J	0.0004	0.78	0.0001	73.09		0.0003

Table E-3
PDT DRE GC Method 8010/8020 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)	Mass Removed (lbs/hr)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)		
C008	11/21/95	1,1-DICHLOROETHENE	10	5.00 U	0.0003	0.41	0.0001		
C008	11/21/95	1,2,4-TRIMETHYLBENZENE	10	1.34 J	0.0003	0.09 J	0.0002	93.42	0.0002
C008	11/21/95	1,2-DICHLOROBENZENE	10	1.23 J	0.0003	0.10 J	0.0002	92.19	0.0003
C008	11/21/95	BENZENE	10	5.00 U		0.31	0.0004		
C008	11/21/95	C-1,2-DICHLOROETHENE	10	1.73 J	0.0003	0.25 U	0.0004	>85.55	0.0002
C008	11/21/95	CHLOROBENZENE	10	5.00 U		0.25 U			
C008	11/21/95	ETHYLBENZENE	10	1.75 J	0.0003	0.25 U	0.0004	>85.71	0.0002
C008	11/21/95	FREON 113	10	5.00 U		0.47	0.0001		
C008	11/21/95	FREON 12	10	5.00 U		0.25 U			
C008	11/21/95	M, P-XYLENES	10	5.07	0.0008	0.09 J	0.0002	98.15	0.0008
C008	11/21/95	METHYLENE CHLORIDE	10	5.78	0.0005	2.51	0.0002	56.48	0.0003
C008	11/21/95	O-XYLENE	10	5.00 U		0.25 U			
C008	11/21/95	TETRACHLOROETHENE	10	51.27	0.0133	0.68	0.0002	98.68	0.0131
C008	11/21/95	TOLUENE	10	32.59	0.0047	0.32	0.0005	99.02	0.0046
C008	11/21/95	TRICHLOROETHENE	10	69.85	0.0143	0.44	0.0001	99.38	0.0142
C008	11/21/95	VINYL CHLORIDE	10	5.00 U		0.25 U			
		Total		342.75	0.0703	54.98	0.0111	>84.19	0.0592
C010	11/30/95	1,1,1-TRICHLOROETHANE	10	184.44	0.0384	22.59	0.0047	87.75	0.0337
C010	11/30/95	1,1-DICHLOROETHANE	10	3.73 J	0.0006	0.47 U	0.0001	>87.44	0.0005
C010	11/30/95	1,1-DICHLOROETHENE	10	2.79 J	0.0004	0.47 U	0.0001	>83.21	0.0004
C010	11/30/95	1,2,4-TRIMETHYLBENZENE	10	23.51	0.0044	0.06 J	0.0001	99.75	0.0044
C010	11/30/95	1,2-DICHLOROBENZENE	10	44.91 J	0.0103	0.26 J	0.0001	99.42	0.0102
C010	11/30/95	BENZENE	10	3.82 U		0.47 U			
C010	11/30/95	C-1,2-DICHLOROETHENE	10	2.87 J	0.0004	0.47 U	0.0001	>83.68	0.0004
C010	11/30/95	CHLOROBENZENE	10	1.05 J	0.0002	0.47 U	0.0001	>55.60	0.0001
C010	11/30/95	ETHYLBENZENE	10	3.99	0.0007	0.47 U	0.0001	>88.27	0.0006
C010	11/30/95	FREON 113	10	3.82 U		0.20 J	0.0004		
C010	11/30/95	FREON 12	10	3.82 U		0.47 U			
C010	11/30/95	M, P-XYLENES	10	14.52	0.0024	0.47 U	0.0001	>96.78	0.0023
C010	11/30/95	METHYLENE CHLORIDE	10	5.35	0.0004	0.29 J	0.0002	94.58	0.0004
C010	11/30/95	O-XYLENE	10	4.75	0.0008	0.47 U	0.0001	>90.14	0.0007
C010	11/30/95	TETRACHLOROETHENE	10	69.65	0.0180	0.12 J	0.0003	99.83	0.0180
C010	11/30/95	TOLUENE	10	56.01	0.0081	0.47 U	0.0001	>99.16	0.0080
C010	11/30/95	TRICHLOROETHENE	10	95.34	0.0195	0.47 U	0.0001	>99.51	0.0194
C010	11/30/95	VINYL CHLORIDE	10	3.82 U		0.47 U			
		Total		512.89	0.1046	23.53	0.0056	>94.68	0.0990
C011	12/6/95	1,1,1-TRICHLOROETHANE	10	184.64	0.0384	30.97 E	0.0064	83.23	0.0320
C011	12/6/95	1,1-DICHLOROETHANE	10	4.58 J	0.0007	0.88	0.0001	80.91	0.0006
C011	12/6/95	1,1-DICHLOROETHENE	10	3.28 J	0.0005	1.03	0.0002	68.70	0.0003

Table E-3
PDT DRE GC Method 8010/8020 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)	Mass Removed (lbs/hr)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)		
C011	12/6/95	1,2,4-TRIMETHYLBENZENE	10	7.25	0.0014	0.15 J	0.00003	97.89	0.0013
C011	12/6/95	1,2-DICHLOROETHANE	10	3.96 J	0.0009	0.23 J	0.0001	94.15	0.0009
C011	12/6/95	BENZENE	10	5.00 U		0.13 J	0.00002		
C011	12/6/95	C-1,2-DICHLOROETHENE	10	2.68 J	0.0004	0.25 U	0.00004	>90.68	0.0004
C011	12/6/95	CHLOROBENZENE	10	1.00 J	0.0002	0.25 U	0.00004	>74.87	0.0001
C011	12/6/95	ETHYLBENZENE	10	4.54 J	0.0008	0.25 U	0.00004	>94.50	0.0007
C011	12/6/95	FREON 113	10	5.00 U		0.48	0.0001		
C011	12/6/95	FREON 12	10	5.00 U		0.25 U			
C011	12/6/95	M, P-XYLENES	10	9.19	0.0015	0.25 U	0.00004	>97.28	0.0015
C011	12/6/95	METHYLENE CHLORIDE	10	5.30	0.0004	3.22	0.0003	39.23	0.0002
C011	12/6/95	O-XYLENE	10	2.75 J	0.0005	0.25 U	0.00004	>90.91	0.0004
C011	12/6/95	TETRACHLOROETHENE	10	55.94	0.0145	0.29	0.0001	99.49	0.0144
C011	12/6/95	TOLUENE	10	46.44	0.0067	1.00	0.0001	97.84	0.0065
C011	12/6/95	TRICHLOROETHENE	10	83.14	0.0170	0.18 J	0.00004	99.79	0.0170
C011	12/6/95	VINYL CHLORIDE	10	5.00 U		0.25 U			
		Total		414.70	0.0838	38.56	0.0077	>90.87	0.0762
C012	12/7/95	1,1,1-TRICHLOROETHANE	10	176.92	0.0368	41.04	0.0085	76.80	0.0283
C012	12/7/95	1,1-DICHLOROETHANE	10	3.82 J	0.0006	1.07	0.0002	71.99	0.0004
C012	12/7/95	1,1-DICHLOROETHENE	10	5.55 U		1.50	0.0002		
C012	12/7/95	1,2,4-TRIMETHYLBENZENE	10	19.54 J	0.0037	0.47 J	0.0001	97.60	0.0036
C012	12/7/95	1,2-DICHLOROETHENE	10	34.75 J	0.0080	0.91 J	0.0002	97.39	0.0078
C012	12/7/95	BENZENE	10	5.55 U		0.21 J	0.00003		
C012	12/7/95	C-1,2-DICHLOROETHENE	10	2.91 J	0.0004	0.47 U	0.0001	>83.93	0.0004
C012	12/7/95	CHLOROBENZENE	10	1.15 J	0.0002	0.47 U	0.0001	>59.41	0.0001
C012	12/7/95	ETHYLBENZENE	10	5.60	0.0009	0.47 U	0.0001	>91.65	0.0009
C012	12/7/95	FREON 113	10	5.55 U		0.53	0.0001		
C012	12/7/95	FREON 12	10	5.55 U		0.47 U			
C012	12/7/95	M, P-XYLENES	10	13.38	0.0022	0.18 J	0.00003	98.68	0.0022
C012	12/7/95	METHYLENE CHLORIDE	10	4.37 J	0.0003	4.70	0.0004	>90.25	-0.00003
C012	12/7/95	O-XYLENE	10	4.80 J	0.0008	0.47 U	0.0001	>90.25	0.0007
C012	12/7/95	TETRACHLOROETHENE	10	71.94	0.0186	1.55	0.0004	97.84	0.0182
C012	12/7/95	TOLUENE	10	56.56	0.0081	1.96	0.0003	96.53	0.0078
C012	12/7/95	TRICHLOROETHENE	10	87.03	0.0178	1.41	0.0003	98.39	0.0175
C012	12/7/95	VINYL CHLORIDE	10	5.55 U		0.47 U			
		Total		482.77	0.0985	55.53	0.0110	>88.79	0.0875
C013	12/14/95	1,1,1-TRICHLOROETHANE	12	212.54	0.0531	35.65 E	0.0089	83.23	0.0442
C013	12/14/95	1,1-DICHLOROETHANE	12	5.24	0.0010	1.15	0.0002	78.04	0.0008
C013	12/14/95	1,1-DICHLOROETHENE	12	4.44 J	0.0008	0.38 J	0.0001	91.52	0.0007
C013	12/14/95	1,2,4-TRIMETHYLBENZENE	12	8.42 J	0.0019	0.05 J	0.00001	99.45	0.0019

Table E-3
PDT DRE GC Method 8010/8020 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)	Mass Removed (lbs/hr)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)		
C013	12/14/95	1,2-DICHLOROETHANE	12	1.59 J	0.0004	0.50 UJ	0.0001	>68.45	0.0003
C013	12/14/95	BENZENE	12	5.00 U		0.20 J	0.00003		
C013	12/14/95	C-1,2-DICHLOROETHENE	12	3.60 J	0.0007	0.50 U	0.0001	>86.12	0.0006
C013	12/14/95	CHLOROETHANE	12	5.00 U		0.50 U			
C013	12/14/95	ETHYLENE	12	4.18 J	0.0008	0.50 U	0.0001	>88.03	0.0007
C013	12/14/95	FREON 113	12	5.00 U		0.49 J	0.0001		
C013	12/14/95	FREON 12	12	5.00 U		0.50 U			
C013	12/14/95	M, P-XYLENES	12	10.09	0.0020	0.50 U	0.0001	>95.05	0.0019
C013	12/14/95	METHYLENE CHLORIDE	12	6.80	0.0006	2.93	0.0003	56.91	0.0004
C013	12/14/95	O-XYLENE	12	3.09 J	0.0006	0.50 U	0.0001	>83.81	0.0005
C013	12/14/95	TETRACHLOROETHENE	12	67.41	0.0209	0.12 J	0.0004	99.83	0.0209
C013	12/14/95	TOLUENE	12	49.44	0.0085	0.50 U	0.0001	>98.99	0.0084
C013	12/14/95	TRICHLOROETHENE	12	102.44	0.0252	0.50 U	0.0001	>99.51	0.0251
C013	12/14/95	VINYL CHLORIDE	12	5.00 UJ		0.50 UJ			
		Total		479.28	0.1166	40.96	0.0104	>91.08	0.1062
C014	12/14/95	1,1,1-TRICHLOROETHANE	12	176.35 E	0.0440	37.87	0.0095	78.53	0.0346
C014	12/14/95	1,1-DICHLOROETHANE	12	5.07	0.0009	1.24	0.0002	75.54	0.0007
C014	12/14/95	1,1-DICHLOROETHENE	12	4.49	0.0008	1.25	0.0002	72.22	0.0006
C014	12/14/95	1,2,4-TRIMETHYLBENZENE	12	23.13	0.0052	0.41 U	0.0001	>98.23	0.0051
C014	12/14/95	1,2-DICHLOROETHENE	12	5.99 J	0.0016	0.41 UJ	0.0001	>93.17	0.0015
C014	12/14/95	BENZENE	12	3.33 U		0.21 J	0.00003		
C014	12/14/95	C-1,2-DICHLOROETHENE	12	3.76	0.0007	0.41 U	0.0001	>89.12	0.0006
C014	12/14/95	CHLOROETHANE	12	0.99 J	0.0002	0.41 U	0.0001	>58.65	0.0001
C014	12/14/95	ETHYLENE	12	5.08	0.0010	0.41 U	0.0001	>91.95	0.0009
C014	12/14/95	FREON 113	12	1.32 J	0.0003	0.67	0.0002	49.05	0.0002
C014	12/14/95	FREON 12	12	3.33 U		0.41 U			
C014	12/14/95	M, P-XYLENES	12	13.27	0.0026	0.41 U	0.0001	>96.92	0.0026
C014	12/14/95	METHYLENE CHLORIDE	12	6.45	0.0006	3.22	0.0003	50.03	0.0003
C014	12/14/95	O-XYLENE	12	3.78	0.0008	0.41 U	0.0001	>89.18	0.0007
C014	12/14/95	TETRACHLOROETHENE	12	70.36	0.0218	0.40 J	0.0001	99.43	0.0217
C014	12/14/95	TOLUENE	12	53.05	0.0092	0.41 U	0.0001	>99.23	0.0091
C014	12/14/95	TRICHLOROETHENE	12	91.53	0.0225	0.25 J	0.0001	99.73	0.0224
C014	12/14/95	VINYL CHLORIDE	12	3.33 UJ		0.41 UJ			
		Total		464.63	0.1124	45.10	0.0113	>89.96	0.1011
C015	12/18/95	1,1,1-TRICHLOROETHANE	12	195.56	0.0488	29.15 E	0.0073	85.09	0.0416
C015	12/18/95	1,1-DICHLOROETHANE	12	5.21	0.0010	1.00	0.0002	80.83	0.0008
C015	12/18/95	1,1-DICHLOROETHENE	12	3.69 J	0.0007	0.79	0.0001	78.70	0.0005
C015	12/18/95	1,2,4-TRIMETHYLBENZENE	12	31.77	0.0071	0.05 J	0.00001	99.84	0.0071
C015	12/18/95	1,2-DICHLOROETHENE	12	53.44 J	0.0147	0.22 J	0.0001	99.59	0.0146

Table E-3
PDT DRE GC Method 8010/8020 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)	Mass Removed (lbs/hr)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)		
C015	12/18/95	BENZENE	12	5.00 U		0.13 J	0.00002		
C015	12/18/95	C-1,2-DICHLOROETHANE	12	3.50 J	0.0006	0.11 J	0.00002	96.94	0.0006
C015	12/18/95	CHLOROBENZENE	12	1.20 J	0.0003	0.50 U	0.0001	>58.33	0.0001
C015	12/18/95	ETHYLBENZENE	12	7.89	0.0016	0.50 U	0.0001	>93.66	0.0015
C015	12/18/95	FREON 113	12	1.84 J	0.0005	0.55	0.0001	69.91	0.0003
C015	12/18/95	FREON 12	12	5.00 U		0.50 U			
C015	12/18/95	M, P-XYLENES	12	19.55	0.0039	0.50 U	0.0001	>97.44	0.0038
C015	12/18/95	METHYLENE CHLORIDE	12	6.88	0.0007	2.36	0.0002	65.66	0.0004
C015	12/18/95	O-XYLENE	12	6.13	0.0012	0.50 U	0.0001	>91.84	0.0011
C015	12/18/95	TETRACHLOROETHANE	12	75.31	0.0234	0.23 J	0.0001	99.69	0.0233
C015	12/18/95	TOLUENE	12	70.82	0.0122	0.39 J	0.0001	99.45	0.0122
C015	12/18/95	TRICHLOROETHANE	12	97.52	0.0240	0.26 J	0.0001	99.73	0.0239
C015	12/18/95	VINYL CHLORIDE	12	5.00 U		0.50 U			
		Total		580.31	0.1406	35.25	0.0087	>93.82	0.1319
C016	12/19/95	1,1,1-TRICHLOROETHANE	10	153.40	0.0319	40.47	0.0084	73.62	0.0235
C016	12/19/95	1,1-DICHLOROETHANE	10	3.95	0.0006	0.98	0.0002	75.13	0.0005
C016	12/19/95	1,1-DICHLOROETHANE	10	2.95 J	0.0004	0.75 J	0.0001	74.67	0.0003
C016	12/19/95	1,2,4-TRIMETHYLBENZENE	10	36.53	0.0068	0.15 J	0.0003	99.59	0.0068
C016	12/19/95	1,2-DICHLOROETHANE	10	90.60 J	0.0208	0.43 J	0.0001	99.53	0.0207
C016	12/19/95	BENZENE	10	3.46 U		0.31 J	0.0004		
C016	12/19/95	C-1,2-DICHLOROETHANE	10	2.85 J	0.0004	0.90 U	0.0001	>68.41	0.0003
C016	12/19/95	CHLOROBENZENE	10	3.46 U		0.90 U			
C016	12/19/95	ETHYLBENZENE	10	5.71	0.0009	0.90 U	0.0001	>84.25	0.0008
C016	12/19/95	FREON 113	10	1.33 J	0.0003	0.65 J	0.0001	51.09	0.0001
C016	12/19/95	FREON 12	10	3.46 U		0.90 U			
C016	12/19/95	M, P-XYLENES	10	17.53	0.0029	0.90 U	0.0001	>94.87	0.0028
C016	12/19/95	METHYLENE CHLORIDE	10	5.76	0.0005	2.57	0.0002	55.33	0.0003
C016	12/19/95	O-XYLENE	10	5.16	0.0009	0.90 U	0.0001	>82.58	0.0007
C016	12/19/95	TETRACHLOROETHANE	10	65.40	0.0169	0.39 J	0.0001	99.41	0.0168
C016	12/19/95	TOLUENE	10	59.28	0.0085	0.90 U	0.0001	>98.48	0.0084
C016	12/19/95	TRICHLOROETHANE	10	78.73	0.0161	0.90 U	0.0002	>98.86	0.0159
C016	12/19/95	VINYL CHLORIDE	10	3.46 U		0.90 U			
		Total		529.16	0.1080	46.70	0.0102	>90.57	0.0979
C017	1/4/96	1,1,1-TRICHLOROETHANE	10	162.93 E	0.0339	32.09	0.0067	80.30	0.0272
C017	1/4/96	1,1-DICHLOROETHANE	10	4.06	0.0006	0.85 U	0.0001	>79.08	0.0005
C017	1/4/96	1,1-DICHLOROETHANE	10	3.21 J	0.0005	0.85 U	0.0001	>73.56	0.0004
C017	1/4/96	1,2,4-TRIMETHYLBENZENE	10	38.92	0.0073	2.23	0.0004	94.27	0.0069
C017	1/4/96	1,2-DICHLOROETHANE	10	105.24 J	0.0241	5.88 J	0.0013	94.41	0.0228
C017	1/4/96	BENZENE	10	3.27 U		0.85 U			

Table E-3
PDT DRE GC Method 8010/8020 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)	Mass Removed (lbs/hr)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)		
C017	1/4/96	C-1,2-DICHLOROETHENE	10	2.55 J	0.0004	0.85 U	0.0001	>66.72	0.0003
C017	1/4/96	CHLOROBENZENE	10	2.28 J	0.0004	0.85 U	0.0001	>62.70	0.0003
C017	1/4/96	ETHYLBENZENE	10	8.31	0.0014	0.85 U	0.0001	>89.78	0.0012
C017	1/4/96	FREON 113	10	1.51 J	0.0003	0.85 U	0.0002	>43.85	0.0001
C017	1/4/96	FREON 12	10	3.27 U		0.85 U			
C017	1/4/96	M, P-XYLENES	10	22.62	0.0037	0.59 J	0.0001	97.38	0.0036
C017	1/4/96	METHYLENE CHLORIDE	10	7.66	0.0006	1.02	0.0001	86.71	0.0005
C017	1/4/96	O-XYLENE	10	7.36	0.0012	0.85 U	0.0001	>88.46	0.0011
C017	1/4/96	TETRACHLOROETHENE	10	97.39	0.0252	2.09	0.0005	97.85	0.0247
C017	1/4/96	TOLUENE	10	76.78	0.0110	0.75 J	0.0001	99.02	0.0109
C017	1/4/96	TRICHLOROETHENE	10	87.10	0.0178	0.68 J	0.0001	99.23	0.0177
C017	1/4/96	VINYL CHLORIDE	10	3.27 U		0.85 U			
		Total		627.91	0.1286	45.34	0.0104	>91.90	0.1182
C018	1/10/96	1,1,1-TRICHLOROETHANE	10	124.32	0.0259	11.58 E	0.0024	90.69	0.0235
C018	1/10/96	1,1-DICHLOROETHANE	10	2.96 J	0.0005	0.20	0.00003	93.21	0.0004
C018	1/10/96	1,1-DICHLOROETHENE	10	2.75 J	0.0004	0.17 U	0.00003	>93.84	0.0004
C018	1/10/96	1,2,4-TRIMETHYLBENZENE	10	16.20	0.0030	0.30	0.0001	98.12	0.0030
C018	1/10/96	1,2-DICHLOROETHENE	10	28.95 J	0.0066	0.97 J	0.0002	96.65	0.0064
C018	1/10/96	BENZENE	10	5.43	0.0007	0.17 U	0.00002	>96.87	0.0006
C018	1/10/96	C-1,2-DICHLOROETHENE	10	1.91 J	0.0003	0.17 U	0.00003	>91.13	0.0003
C018	1/10/96	CHLOROBENZENE	10	0.86 J	0.0002	0.17 U	0.00003	>80.21	0.0001
C018	1/10/96	ETHYLBENZENE	10	4.79	0.0008	0.17 U	0.00003	>96.45	0.0008
C018	1/10/96	FREON 113	10	1.46 J	0.0003	0.19	0.00004	86.85	0.0003
C018	1/10/96	FREON 12	10	3.53 U		0.17 U			
C018	1/10/96	M, P-XYLENES	10	13.20	0.0022	0.08 J	0.00001	99.42	0.0022
C018	1/10/96	METHYLENE CHLORIDE	10	5.65	0.0004	0.91	0.0001	83.90	0.0004
C018	1/10/96	O-XYLENE	10	4.01	0.0007	0.17 U	0.00003	>95.77	0.0006
C018	1/10/96	TETRACHLOROETHENE	10	62.69	0.0162	0.26	0.0001	99.58	0.0161
C018	1/10/96	TOLUENE	10	54.08	0.0078	0.71	0.0001	98.68	0.0077
C018	1/10/96	TRICHLOROETHENE	10	61.47	0.0126	0.08 J	0.00002	99.87	0.0126
C018	1/10/96	VINYL CHLORIDE	10	3.53 U		0.17 U			
		Total		390.74	0.0785	15.29	0.0032	>95.94	0.0753
C019	1/10/96	1,1,1-TRICHLOROETHANE	10	131.59 E	0.0274	15.56	0.0032	88.18	0.0241
C019	1/10/96	1,1-DICHLOROETHANE	10	3.29	0.0005	0.50 U	0.0001	>84.82	0.0004
C019	1/10/96	1,1-DICHLOROETHENE	10	3.37	0.0005	0.50 U	0.0001	>85.16	0.0004
C019	1/10/96	1,2,4-TRIMETHYLBENZENE	10	20.49	0.0038	0.10 J	0.00002	99.54	0.0038
C019	1/10/96	1,2-DICHLOROETHENE	10	35.14 J	0.0081	0.24 J	0.0001	99.32	0.0080
C019	1/10/96	BENZENE	10	2.50 U		0.50 U			
C019	1/10/96	C-1,2-DICHLOROETHENE	10	1.92 J	0.0003	0.50 U	0.0001	>73.92	0.0002

Table E-3
PDT DRE GC Method 8010/8020 Results Presented by Sample

Sample	Date	Parameter	Flow (scfm)	Inlet		Outlet		DRE (%)	Mass Removed (lbs/hr)
				Conc. (ppmv)	Mass Rate (lbs/hr)	Conc. (ppmv)	Mass Rate (lbs/hr)		
C019	1/10/96	CHLOROENZENE	10	1.18 J	0.0002	0.50 U	0.0001	>57.79	0.0001
C019	1/10/96	ETHYLBENZENE	10	5.70	0.0009	0.50 U	0.0001	>91.23	0.0009
C019	1/10/96	FREON 113	10	1.24 J	0.0003	0.24 J	0.0001	80.79	0.0002
C019	1/10/96	FREON 12	10	2.50 U		0.50 U			
C019	1/10/96	M, P-XYLENES	10	14.10	0.0023	0.50 U	0.0001	>96.45	0.0023
C019	1/10/96	METHYLENE CHLORIDE	10	5.46	0.0004	1.16	0.0001	78.85	0.0003
C019	1/10/96	O-XYLENE	10	4.41	0.0007	0.50 U	0.0001	>88.66	0.0006
C019	1/10/96	TETRACHLOROETHENE	10	64.35	0.0166	0.17 J	0.00004	99.74	0.0166
C019	1/10/96	TOLUENE	10	52.76	0.0076	0.50 U	0.0001	>99.05	0.0075
C019	1/10/96	TRICHLOROETHENE	10	62.36	0.0128	0.50 U	0.0001	>99.20	0.0127
C019	1/10/96	VINYL CHLORIDE	10	2.50 U		0.50 U			
		Total		407.37	0.0825	17.46	0.0042	>94.87	0.0783
						Average Pounds Removed			0.0926
U - Compound was analyzed but not detected									
J - Estimated concentration									
E - Concentration is above the linear range of the instrument									

Table E-4

Summary of Total VOC PDT DRE Results by GC Method 8010/8020 Sorted by Sample

Date sampled	Inlet Mass Rate (lbs/hr)	Outlet Mass Rate (lbs/hr)	DRE (%)	Mass Removed (lbs/hr)
11/09/95	0.1655	0.0427	> 74.20	0.1228
11/13/95	0.1409	0.0374	> 73.48	0.1036
11/15/95	0.0693	0.0049	> 92.87	0.0644
11/20/95	0.0815	0.0148	> 81.89	0.0667
11/21/95	0.0703	0.0109	> 84.48	0.0594
11/30/95	0.1046	0.0055	> 94.72	0.0991
12/06/95	0.0838	0.0075	> 91.01	0.0763
12/07/95	0.0985	0.0107	> 89.16	0.0879
12/14/95	0.1166	0.0102	> 91.21	0.1063
12/14/95	0.1124	0.0113	> 89.99	0.1011
12/18/95	0.1406	0.0087	> 93.83	0.1319
12/19/95	0.1080	0.0102	> 90.60	0.0979
01/04/96	0.1286	0.0104	> 91.90	0.1182
01/10/96	0.0785	0.0032	> 95.94	0.0753
01/10/96	0.0825	0.0042	> 94.87	0.0783
Average from 11/9/95 to 1/10/96	0.1054	0.0128	> 88.68	0.0926
Average from 12/6/95 to 1/10/96	0.1055	0.0085	> 92.06	0.0970

Notes:

An average DRE preceded by a greater than symbol (>) was calculated when a positive inlet concentration was reported with a nondetected outlet concentration.

Table E-5

Total Nonmethane Organic Carbon (TNMOC) DRE Results for Photolytic Destruction Technology

Can #	Date	Inlet Conc. (ppmv)	Outlet Conc. (ppmv)	DRE
C10	11/30/95	3,590	44.5	98.8
C12	12/7/95	5,000	161	96.8
C14	12/14/95	6,030	92.8	98.5

Appendix F

UTI

Figures

- F-1 UTI and GC Methods 1,1,1-TCA DRE Results
- F-2 UTI and GC Methods Methylene Chloride DRE Results
- F-3 UTI and GC Methods TCE DRE Results
- F-4 UTI and GC Methods Toluene DRE Results
- F-5 UTI and GC Methods 1,1-DCE DRE Results
- F-6 UTI and GC Methods Freon 113 DRE Results

Tables

- F-1 DREs for GC Method and UTI Method
- F-2 UTI Field Data

APPENDIX F

Description of UTI Atmospheric Sampling Mass Spectrometer

PTI employs a UTI ASMS for the monitoring of contaminant and effluent components. The UTI is a continuous sampling mass spectrometer, and does not have any chromatographic separation capabilities. The spectrometer sorts out charged gas molecules or ions according to their masses. This instrument is a quadrapole mass spectrometer that is capable of taking a sample directly from atmospheric pressure into the mass analyzer. Sampling is accomplished through a set of orifices in conjunction with three vacuum pumps. The instrument has a linear response over a large dynamic concentration range.

The UTI is not successful at measuring levels of reactive components such as HCl, HF, and chlorine because of interferences caused by reactive metal surfaces within the instrument.

The instrument does not provide direct concentrations; instead, it measures a current output relative to the concentration and atomic mass of the component being measured. Therefore, the output from the UTI system must be multiplied by the relative gain [i.e., the ratio of the unamplified to amplified signal for the benchmark compound (^{40}Ar)] to obtain the actual concentrations.

Example Calculations

Estimation of target species (for example, 1,1,1-TCA) concentration using ^{40}Ar :

1. Atmospheric ^{40}Ar concentration is 0.93 percent or 9,300 ppm
2. Average ^{40}Ar detector response = $1.35 \text{ E-}9$ amps
3. 1,1,1-TCA detector response = $7.5 \text{ E-}11$ amps
4. Calculation of actual 1,1,1-TCA concentration is as follows:

$$\frac{[9,300 \text{ ppm } (^{40}\text{Ar})] \times [7.5 \text{ E-}11 \text{ amps (1,1,1-TCA)}]}{[1.35 \text{ E-}9 \text{ amps } (^{40}\text{Ar})]} = 517 \text{ ppm 1,1,1-TCA}$$

Comparison With GC Data

Despite not being on objective for this report, the following discussion has been included in this document to provide a qualitative comparison between data collected by the UTI and data collected with a gas chromatograph (GC). The comparison is based on a limited number of samples and therefore provides only cursory results.

As can be seen in Figures F-1, F-2, and F-3, both analysis techniques show similar relative trends for several compounds (i.e. 1,1,1-TCA, methylene chloride, and TCE). Of the other three compounds analyzed by both the UTI and the GC method, only toluene (Figure F-4) had a sufficient number of hits for comparison; however, toluene data did not show any distinct trends.

Note that DREs calculated for all compounds from GC data collected on 12/7/96 are in question because greater concentrations of methylene chloride were detected in the outlet sample than in the inlet sample. The 12/7/96 GC outlet sample may have been contaminated.

In most cases the UTI reports slightly higher DREs than those reported by the GC. This might be because the UTI has less sensitivity at low concentrations than the GC, and therefore the chemical "fingerprint" of the PDT outlet stream is not accurately interpreted.

The UTI technology is less sensitive to low concentrations than gas chromatography, because prior to analysis the UTI does not physically separate the compounds in the incoming gas stream. A gas chromatograph employs a column that preferentially retains compounds in a gas stream based on the physical characteristics of the compound. This separation allows the measured quantities of the compounds to be clearly defined even at low concentrations.

Reference

Photolytic Destruction Demonstration, McClellan AFB. Phase 1: Bench Scale Testing to Evaluate Destruction Removal Efficiency of VOCs Using PTI's Photolytic Process. July 12, 1994. Prepared by Process Technologies, Inc., Boise, Idaho.

Figure F-1
UTI and GC Methods
1,1,1-TCA DRE Results

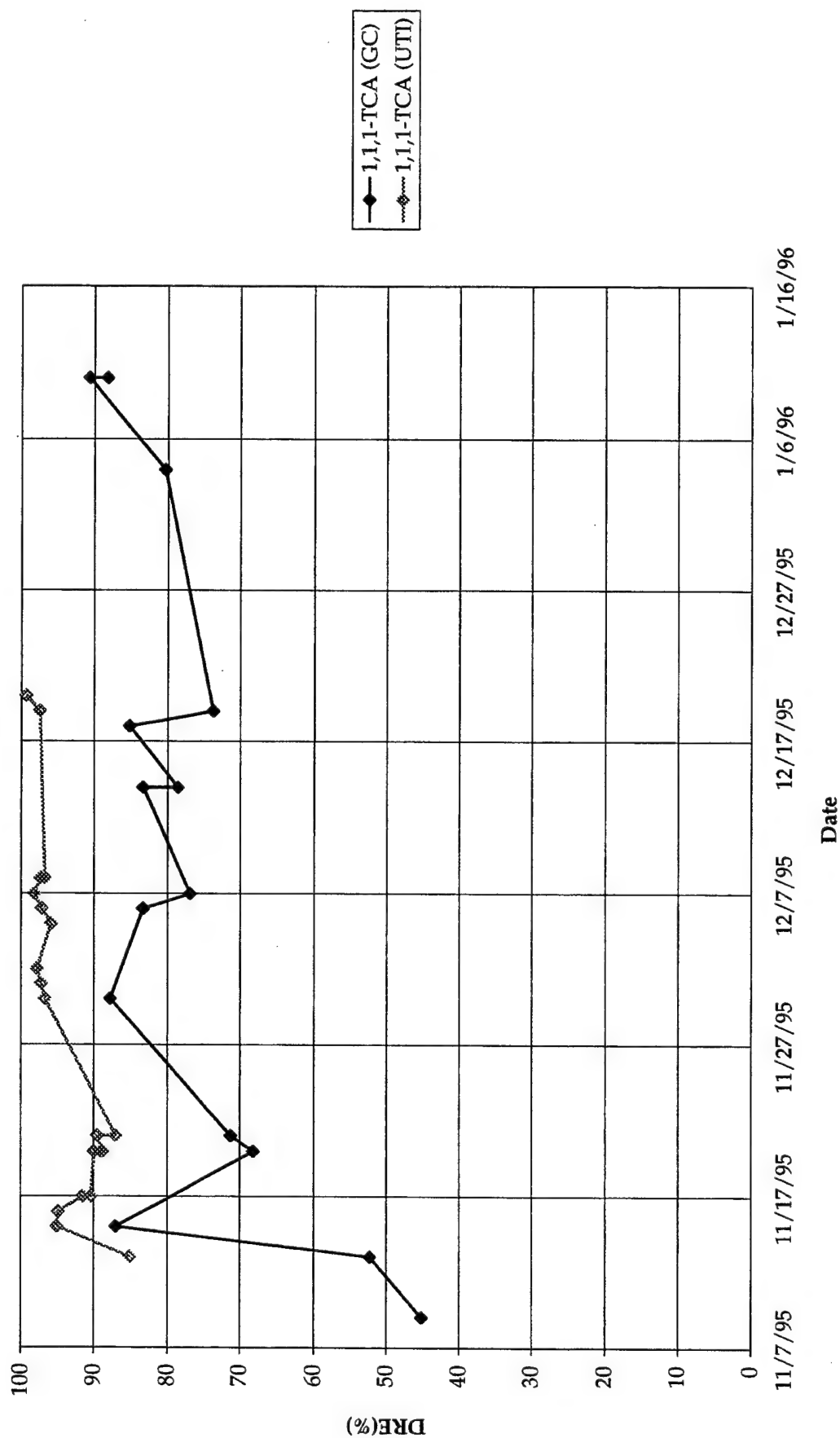


Figure F-2
UTI and GC Methods
Methylene Chloride DRE Results

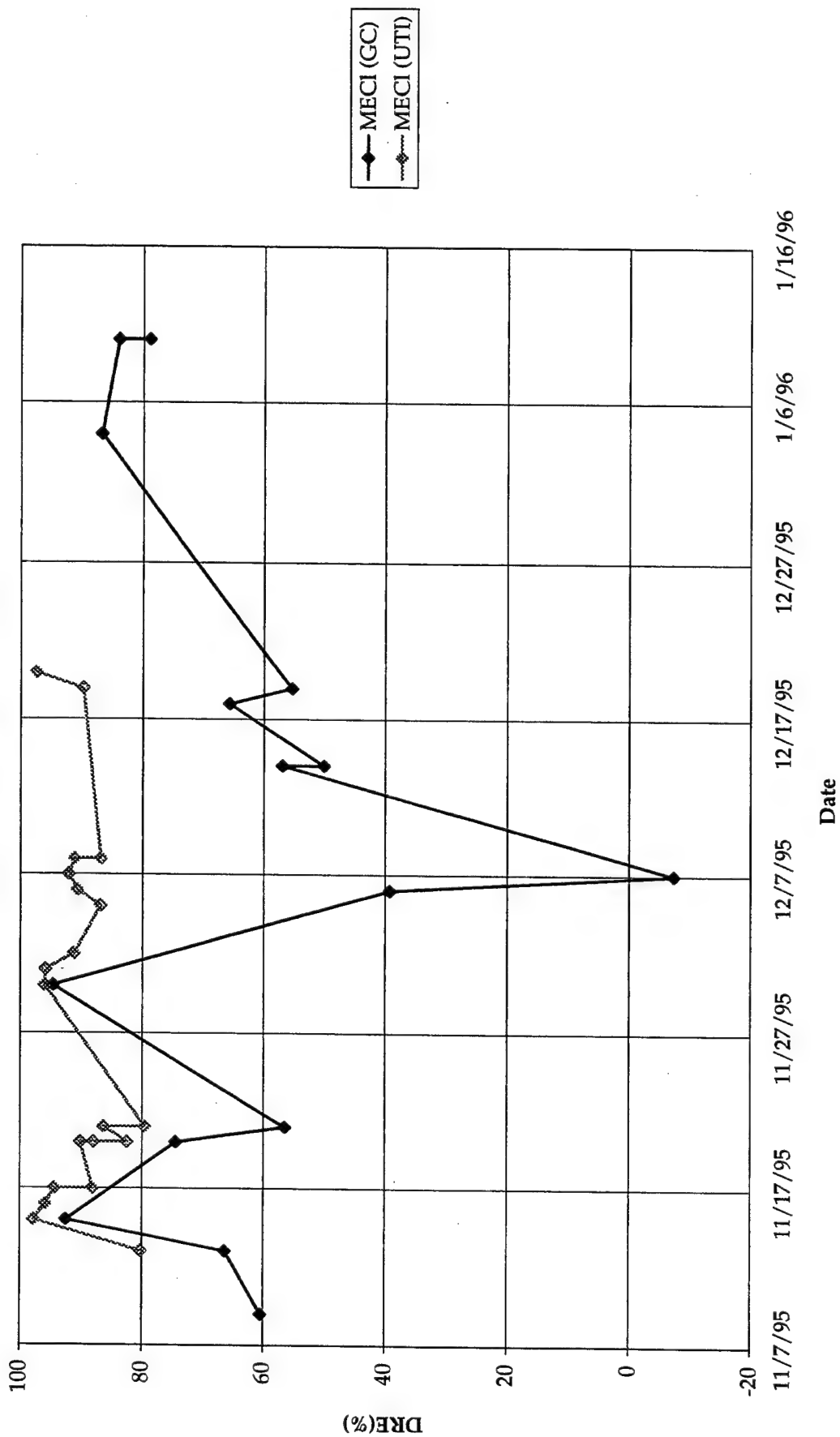


Figure F-3
UTI and GC Methods
TCE DRE Results

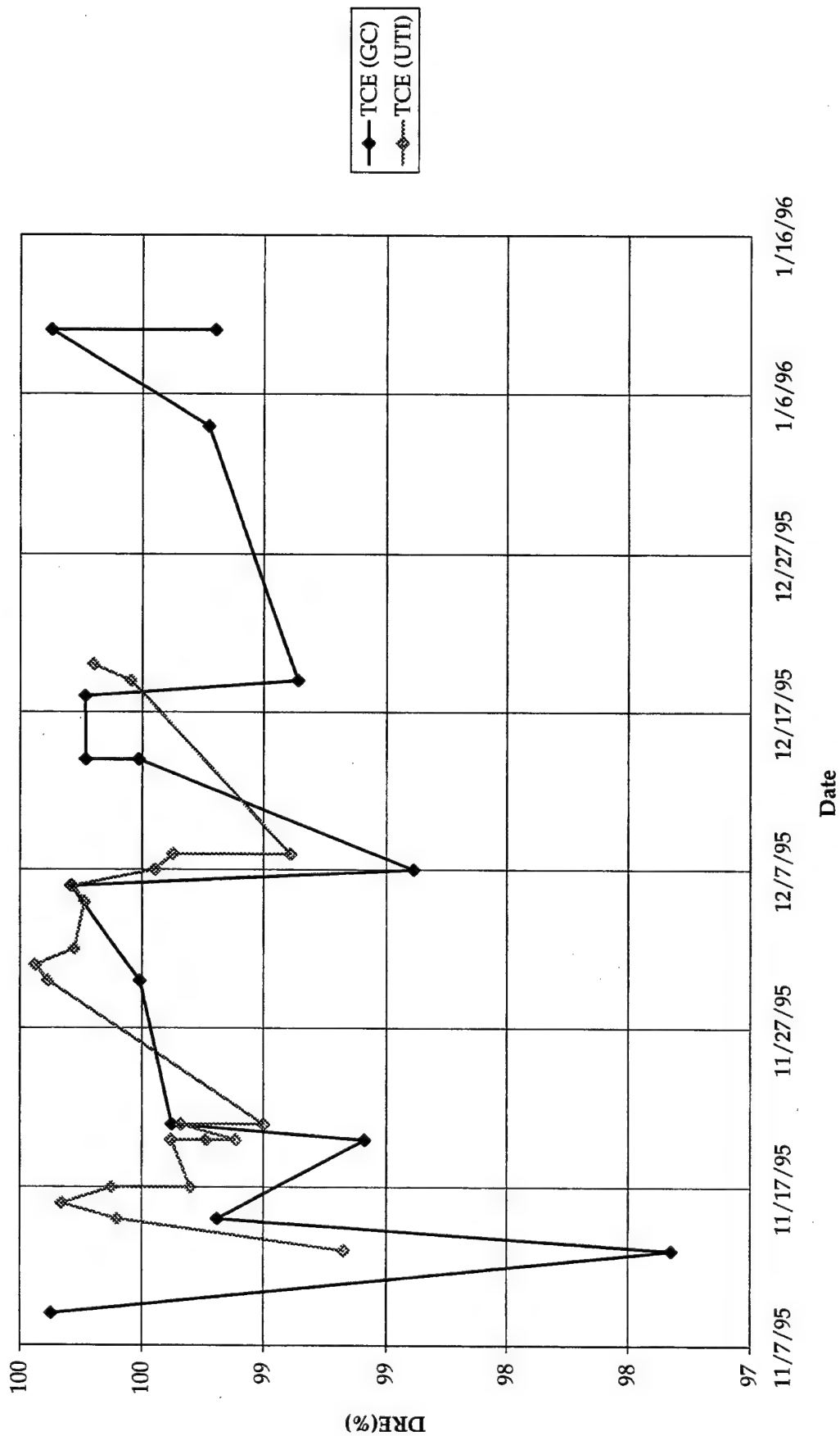


Figure F-4
UTI and GC Methods
Toluene DRE Results

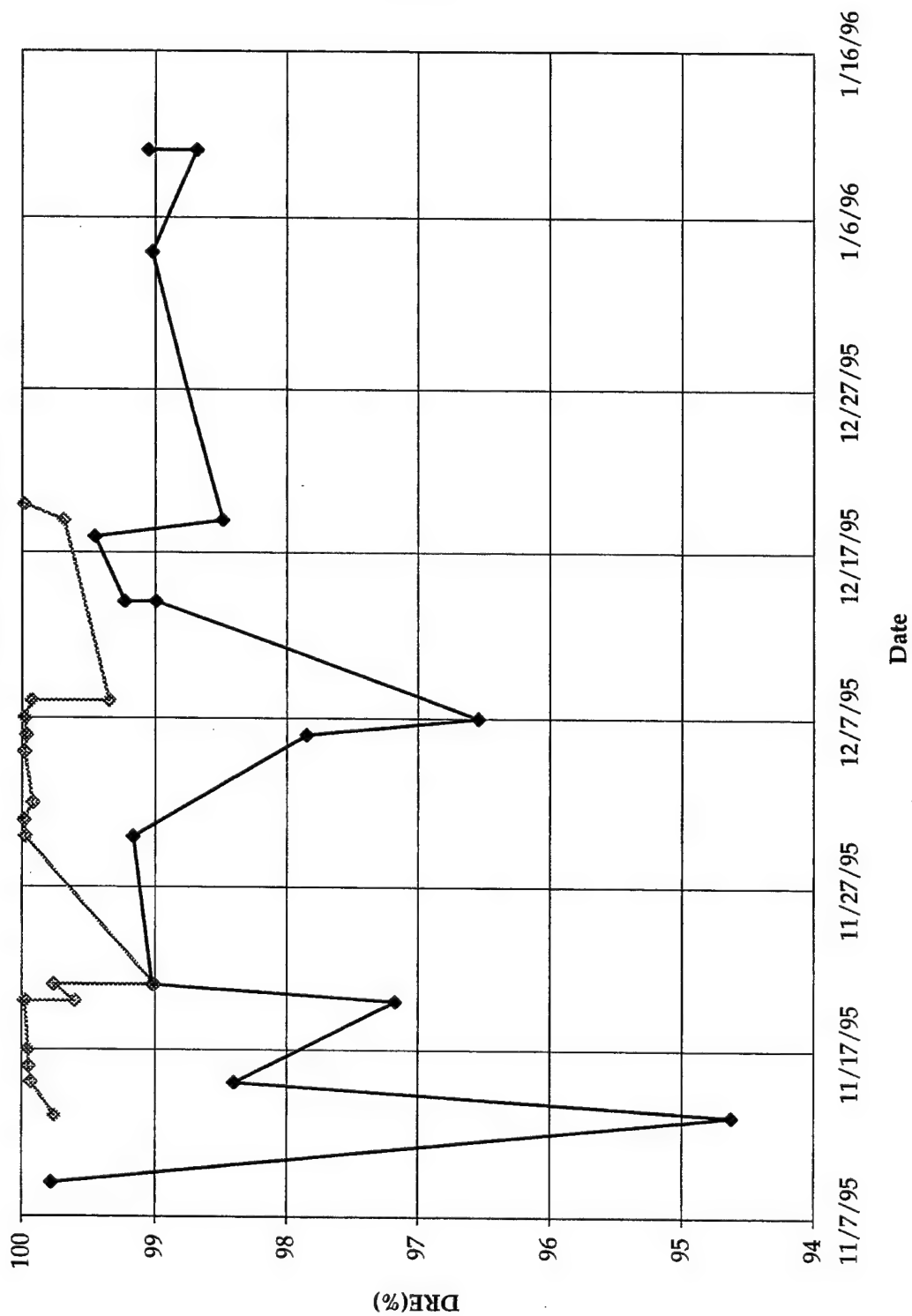


Figure F-5
UTI and GC Methods
1,1-DCE DRE Results

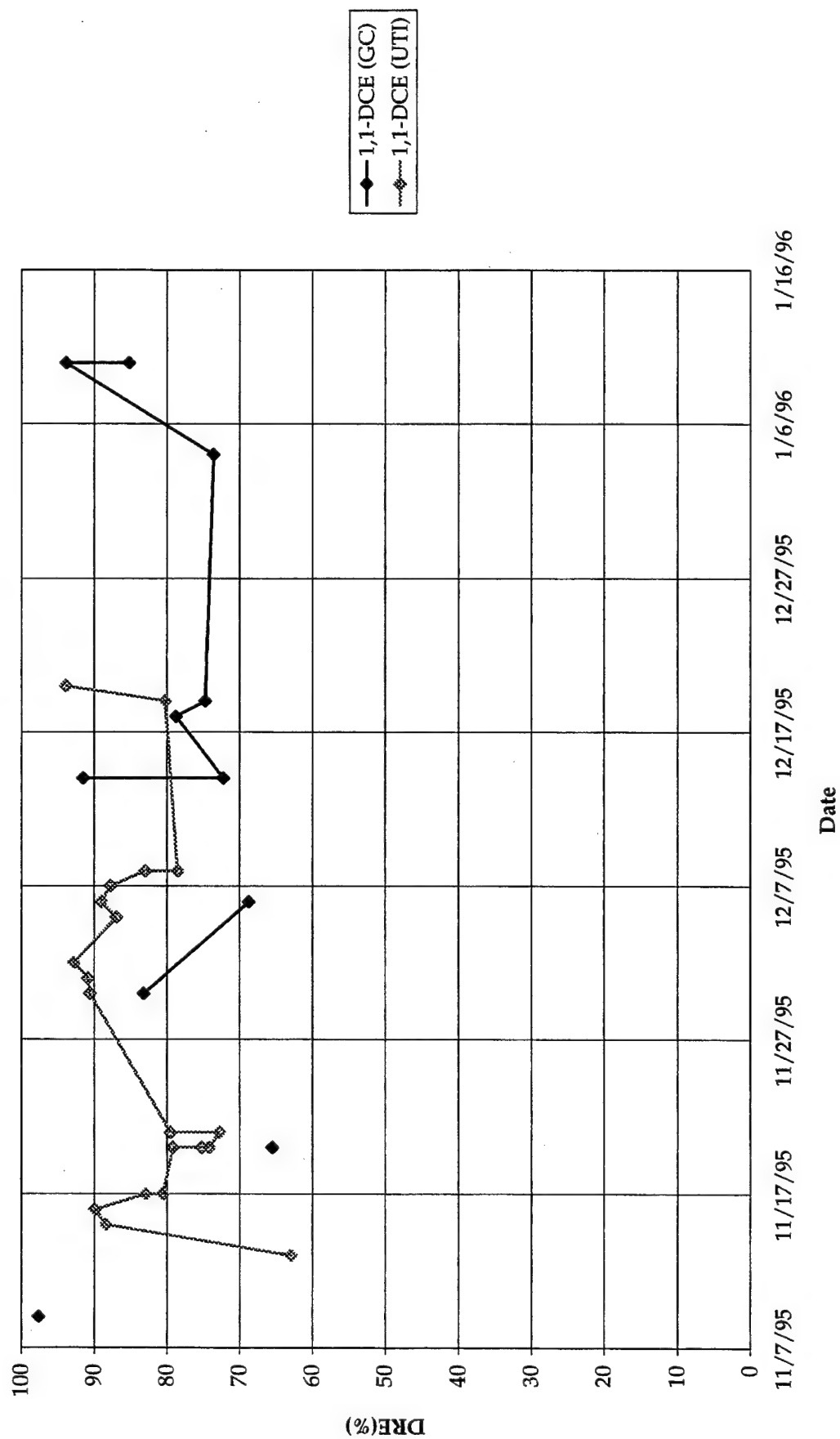


Figure F-6
UTI and GC Methods
Freon 113 DRE Results

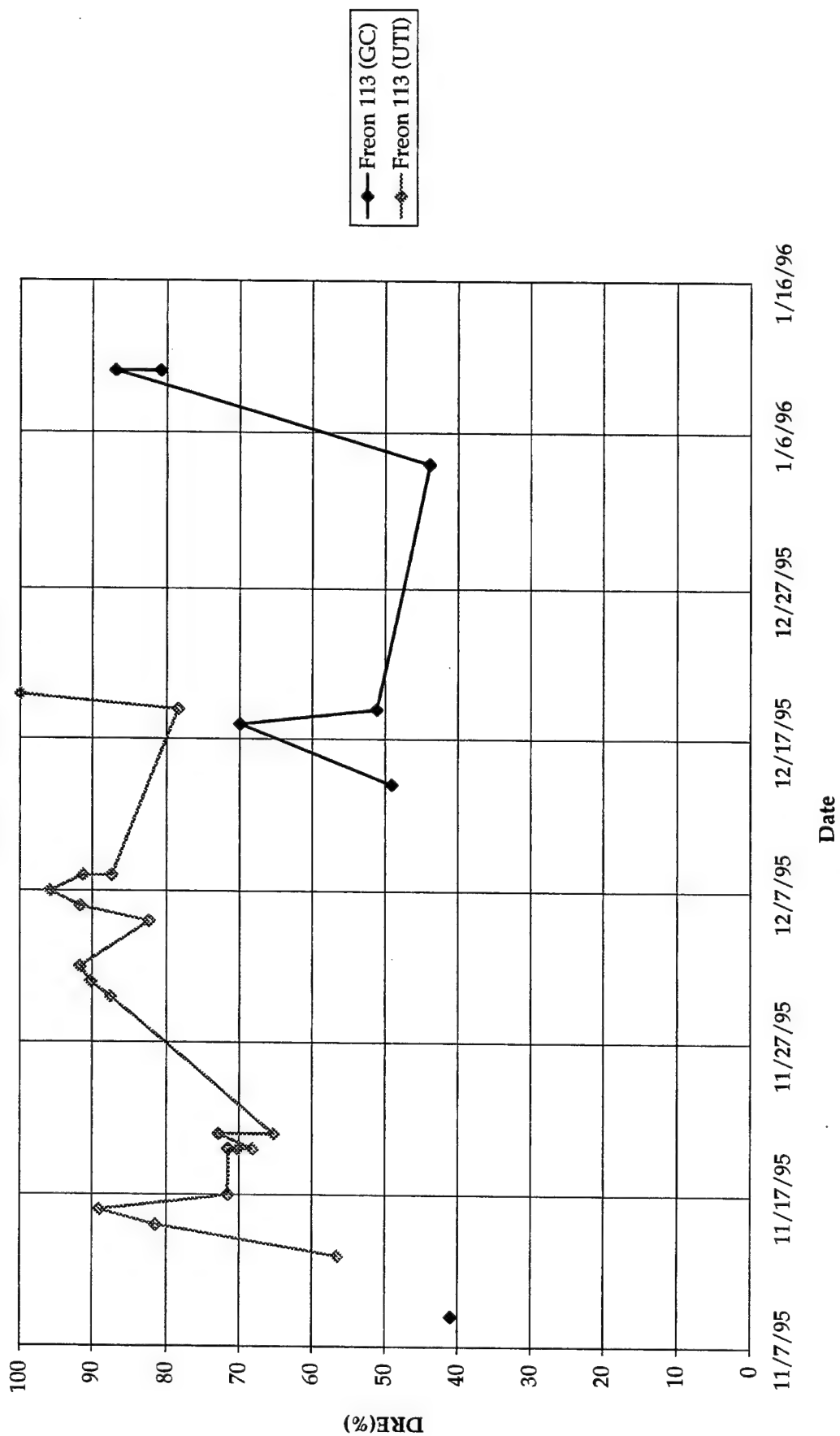


Table F-1

DREs for GC Method

Sample_id	Date	1,1,1-TCA (GC)	1,1-DCE (GC)	Freon 113 (GC)	MECl (GC)	Toluene (GC)	TCE (GC)
C001	11/9/95	45.14	97.66	40.91	60.37	99.78	99.87
C003	11/13/95	52.23			66.32	94.62	97.32
C005	11/15/95	86.95			92.50	98.40	99.19
C007	11/20/95	68.16	65.47		74.41	97.17	98.59
C008	11/21/95	71.18			56.48	99.02	99.38
C010	11/30/95	87.75	83.21		94.58	99.16	99.51
C011	12/6/95	83.23	68.70		39.23	97.84	99.79
C012	12/7/95	76.80			-7.41	96.53	98.39
C013	12/14/95	83.23	91.52		56.91	98.99	99.51
C014	12/14/95	78.53	72.22	49.05	50.03	99.23	99.73
C015	12/18/95	85.09	78.70	69.91	65.66	99.45	99.73
C016	12/19/95	73.62	74.67	51.09	55.33	98.48	98.86
C017	1/4/96	80.30	73.56	43.85	86.71	99.02	99.23
C018	1/10/96	90.69	93.84	86.85	83.90	98.68	99.87
C019	1/10/96	88.18	85.16	80.79	78.85	99.05	99.20

DREs for UTI Method

Sample_id	Date	1,1,1-TCA (UTI)	1,1-DCE (UTI)	Freon 113 (UTI)	MECl (UTI)	Toluene (UTI)	TCE (UTI)
INLET-1	11/13/95	85.06	62.94	56.55	80.23	99.75	98.67
INLET-1	11/15/95	95.04	88.37	81.39	97.73	99.93	99.60
INLET-1	11/16/95	94.85	89.85	88.99	95.83	99.95	99.83
INLET-1	11/17/95	91.55	82.87	71.54	94.36	99.95	99.62
INLET-2	11/17/95	90.38	80.55	71.56	88.10	99.95	99.30
INLET-1	11/20/95	89.95	79.14	71.49	90.19	99.98	99.38
INLET-2	11/20/95	88.99	75.21	70.10	87.95	99.98	99.24
INLET-3	11/20/95	88.75	74.20	68.23	82.43	99.60	99.12
INLET-1	11/21/95	89.55	72.80	72.77	86.28	99.76	99.34
INLET-2	11/21/95	86.96	79.45	65.30	79.56	99.00	99.00
INLET-1	11/30/95	96.73	90.58	87.50	95.95	99.98	99.88
INLET-1	12/1/95	97.24	90.85	90.19	95.78	99.98	99.93
INLET-1	12/2/95	97.78	92.80	91.67	91.23	99.92	99.78
INLET-1	12/5/95	95.88	86.97	82.35	86.80	99.98	99.73
INLET-1	12/6/95	97.18	89.04	91.55	90.68	99.97	99.78
INLET-1	12/7/95	98.22	87.75	95.82	92.07	99.98	99.45
INLET-1	12/8/95	97.28	82.93	91.20	91.14	99.93	99.37
INLET-2	12/8/95	96.71	78.45	87.39	86.79	99.35	98.89
INLET-1	12/19/95	97.47	80.18	78.38	89.72	99.68	99.55
INLET-1	12/20/95	99.29	93.88	99.91	97.35	99.98	99.70

Table F-2
UTI Field Data

UTI Field Data - November								
		TCA	TCE	DCE	Toluene	113	MeCl	Ar 40
11/13/96	Inlet	126.541	75.57611	44.43091	107.3747	4.421311	6.729977	4E-08
	Outlet	18.90492	1.004052	16.46557	0.263536	1.920984	1.330749	4.54E-08
	DRE %	85.06024	98.67147	62.94118	99.75456	56.55172	80.22654	4.27E-08
11/15/96	Inlet	57.06323	33.10539	30.7096	67.29977	2.352225	3.942155	4.34E-08
	Outlet	2.831382	0.132857	3.571897	0.045738	0.437775	0.089297	3.25E-08
	DRE %	95.03817	99.59868	88.36879	99.93204	81.38889	97.73481	3.795E-08
11/16/96	Inlet	43.12412	24.82904	20.16815	44.21311	2.374005	3.11452	3.46E-08
	Outlet	2.221546	0.042906	2.047307	0.021758	0.261358	0.130026	3.29E-08
	DRE %	94.84848	99.82719	89.84881	99.95079	88.99083	95.82517	3.375E-08
11/17/96	Inlet	59.02342	34.41218	25.04684	47.69789	2.678923	3.462998	3.57E-08
	Outlet	4.987588	0.130026	4.290632	0.021758	0.762295	0.195365	3.87E-08
	DRE %	91.54982	99.62215	82.86957	99.95438	71.54472	94.35849	3.72E-08
11/17/96	Inlet	57.71663	33.32319	23.95785	47.2623	2.374005	3.659016	3.6E-08
	Outlet	5.553864	0.195365	4.66089	0.021758	0.675176	0.435597	3.56E-08
	DRE %	90.37736	99.41373	80.54545	99.95396	71.55963	88.09524	3.58E-08
11/20/96	Inlet	119.5714	70.34895	43.12412	99.96956	4.813349	5.771663	4.2E-08
	Outlet	12.02248	0.435597	8.995082	0.021758	1.372131	0.566276	3.84E-08
	DRE %	89.94536	99.3808	79.14141	99.97824	71.49321	90.18868	4.02E-08
11/20/96	Inlet	103.8899	62.726	36.80796	87.99063	4.225293	5.423185	3.88E-08
	Outlet	11.43443	0.479157	9.125761	0.021758	1.263232	0.653396	3.53E-08
	DRE %	88.99371	99.23611	75.2071	99.97527	70.10309	87.95181	3.705E-08
11/20/96	Inlet	107.8103	64.03279	38.33255	87.55504	4.181733	5.205386	3.82E-08
	Outlet	12.13138	0.566276	9.888056	0.348478	1.328571	0.914754	3.44E-08
	DRE %	88.74747	99.11565	74.20455	99.60199	68.22917	82.42678	3.63E-08
11/21/96	Inlet	120.2248	72.52693	40.51054	100.4052	4.878689	6.033021	4.04E-08
	Outlet	12.56698	0.479157	11.02061	0.239578	1.328571	0.827635	3.6E-08
	DRE %	89.5471	99.33934	72.7957	99.76139	72.76786	86.28159	3.82E-08
11/21/96	Inlet	121.096	71.65574	39.63934	98.22717	4.769789	5.967681	3.94E-08
	Outlet	15.7904	0.718735	8.145667	0.977916	1.655269	1.219672	3.67E-08
	DRE %	86.96043	98.99696	79.45055	99.00443	65.2968	79.56204	3.805E-08
11/30/96	Inlet	121.9672	74.92272	37.46136	87.99063	4.181733	5.357845	4.15E-08
	Outlet	3.985714	0.086466	3.528337	0.021758	0.522717	0.216927	3.93E-08
	DRE %	96.73214	99.88459	90.5814	99.97527	87.5	95.95122	4.04E-08
UTI Field Data - December								
		TCA	TCE	DCE	Toluene	113	MeCl	Ar 40
12/1/96	Inlet	162.4778	99.31616	45.9555	125.8876	5.771663	7.230913	4.545E-08
	Outlet	4.486651	0.064686	4.203513	0.021758	0.566276	0.304918	4.32E-08
	DRE %	97.23861	99.93487	90.85308	99.98272	90.18868	95.78313	3.74E-08
12/2/96	Inlet	135.4707	87.11944	39.63934	103.8899	4.443091	6.20726	4.03E-08
	Outlet	3.005621	0.195365	2.853162	0.086466	0.370258	0.544496	4.15E-08
	DRE %	97.78135	99.77575	92.8022	99.91677	91.66667	91.22807	4.04E-08
12/5/96	Inlet	120.007	73.18033	35.93677	94.96019	4.072834	5.444965	4.095E-08
	Outlet	4.944028	0.195365	4.68267	0.021758	0.718735	0.718735	3.05E-08
	DRE %	95.88022	99.73304	86.9697	99.97709	82.35294	86.8	2.87E-08
12/6/96	Inlet	76.8829	46.3911	25.04684	67.08197	1.975433	4.138173	2.96E-08
	Outlet	2.171452	0.101494	2.744262	0.021758	0.166834	0.385504	4.33E-08
	DRE %	97.17564	99.78122	89.04348	99.96756	91.55458	90.68421	4.13E-08
12/7/96	Inlet	107.3747	65.99297	38.76815	96.70258	1.910094	5.684543	4.23E-08
	Outlet	1.910094	0.363724	4.748009	0.021758	0.079932	0.450843	4.35E-08
	DRE %	98.2211	99.44884	87.75281	99.9775	95.81528	92.06897	4.03E-08

Table F-2
UTI Field Data

UTI Field Data - December (continued)								
12/8/96	Inlet	84.07026	58.15222	34.19438	79.49649	1.648735	4.59555	4.19E-08
	Outlet	2.286885	0.363724	5.837002	0.058152	0.145054	0.407283	4.64E-08
	DRE %	97.27979	99.37453	82.92994	99.92685	91.20211	91.13744	4.3E-08
12/8/96	Inlet	92.7822	58.15222	37.89696	85.81265	1.668337	5.227166	4.47E-08
	Outlet	3.04918	0.646862	8.167447	0.559742	0.210393	0.690422	4.59E-08
	DRE %	96.71362	98.88764	78.44828	99.34772	87.38903	86.79167	4.27E-08
12/19/96	Inlet	141.7869	94.30679	36.80796	122.185	3.09274	6.925995	4.43E-08
	Outlet	3.593677	0.429063	7.296253	0.385504	0.668642	0.712201	5.75E-08
	DRE %	97.46544	99.54503	80.17751	99.68449	78.38028	89.71698	5.16E-08
12/20/96	Inlet	158.7752	105.6323	47.69789	138.0843	23.30445	8.799063	5.455E-08
	Outlet	1.126019	0.320164	2.918501	0.021758	0.021758	0.233044	
	DRE %	99.29081	99.69691	93.88128	99.98424	99.90664	97.35149	
High		99.29081	99.93487	93.88128	99.98424	99.90664	97.73481	
Low		85.06024	98.67147	62.94118	99.00443	56.55172	79.56204	
Average		93.55616	99.46789	82.9412	99.82529	80.14105	89.94878	
inlet average		107.0308	65.66054	36.2073	90.03106	4.604721	5.490817	
outlet average		6.669337	0.346701	6.28177	0.165595	0.754258	0.55894	
Corrected ppm Levels - UTI Field Data								
		TCA	TCE	DCE	Toluene	113	MeCl	
inlet average		288.9832	177.2835	55.75924	222.3767	13.1695	12.90342	
outlet average		18.00721	0.936093	9.673926	0.409019	2.157179	1.313509	
weighted average removal		35.09022	22.88718	6.002446	28.81184	1.369826	1.506403	
Total ppm		770.4756						
Weighted average % removal:		95.66792						
Removal Rates								
		TCA	TCE	DCE	Toluene	113	MeCl	
Mass Weight		133.4	131.39	96.94	92.14	187.38	84.93	
% by volume		0.00017	0.000104	5.75E-05	0.000143	7.31E-06	8.72E-06	
DRE %		93.55616	99.46789	82.9412	99.82529	80.14105	89.94878	
Flow Rate (scfm)		12						
Removal Rate		0.042948	0.02759	0.00936	0.026625	0.002223	0.001349	
Total	(lbs/hr)	0.110094						

*Note: The contents and calculations in table F-2 were supplied by Process Technologies Incorporated.

Appendix G

Summary of SVOC and Acetone DRE Results

Tables

- G-1 SVOC DRE Results for Samples Collected on December 20, 1995
- G-2 Acetone DRE Results for Samples Collected on November 30 and December 6, 1995

Table G-1**Semivolatile Organic Compound DRE Results for Samples Collected on December 20, 1995**

Compound	Inlet Conc. (ppb)	Outlet Conc.#1 (ppb)	DRE	Outlet Conc. #2 (ppb)	DRE
1,1,1-Naphthalene	396.9	<6.0	>98.4	<5.6	>98.6
2-Methylnaphthalene	77.4	<5.4	>93.0	<5.0	>93.5

Table G-2
Acetone DRE Results for Samples Collected on November 30 and December 6, 1995

Date	Inlet Conc. (ppmv)	Outlet Conc. (ppmv)	DRE
11/30/95	73.71	0.10	99.9
12/7/95	107.76	9.06	91.6

SVOC and Acetone Results

McClellan AFB		SVE Site		Event 1 SVOC's - Modified EPA Method 5/Method 8270			
Common Inlet		12/22/95		CIPDT5S			
Date:		110.321		Volume Sampled SCF			
Sample ID:		MW		Conc. Units			
Analyte		Micro.gms/liter		Micro.gms/M3			
		ug		Gms./liter			
				Gm.moles/liter			
				Qualifier			
				ppb			
1,1,1-Naphthlene		128	7085.64	2.268	2.27E-06	1.77E-08	396.9
2-Methylnaphthalene		142	1533.52	0.491	4.91E-07	3.46E-09	77.4
2-Chloronaphthalene		162	1500	0.480	4.80E-07	2.96E-09	< 66.4
Acenaphthylene		152	1500	0.480	4.80E-07	3.16E-09	< 70.8
Acenaphthene		154	1500	0.480	4.80E-07	3.12E-09	< 69.8
Flourene		166	1500	0.480	4.80E-07	2.89E-09	< 64.8
Phenanthrene		178	1500	0.480	4.80E-07	2.70E-09	< 60.4
Anthracene		178	1500	0.480	4.80E-07	2.70E-09	< 60.4
Flouranthene		202	1500	0.480	4.80E-07	2.38E-09	< 53.2
Pyrene		202	1500	0.480	4.80E-07	2.38E-09	< 53.2
Benzo (a) anthracene		228	1500	0.480	4.80E-07	2.11E-09	< 47.2
Chrysene		228	1500	0.480	4.80E-07	2.11E-09	< 47.2
Benzo(b)flouranthene		252	1500	0.480	4.80E-07	1.91E-09	< 42.7
Benzo(k)flouranthene		252	1500	0.480	4.80E-07	1.91E-09	< 42.7
Benzo(e)pyrene		252	1500	0.480	4.80E-07	1.91E-09	< 42.7
Benzo(a)pyrene		252	1500	0.480	4.80E-07	1.91E-09	< 42.7
Perylene		252	1500	0.480	4.80E-07	1.74E-09	< 39.0
Indeno (1,2,3-cd) pyrene		276	1500	0.480	4.80E-07	1.73E-09	< 38.7
Dibenz (a, h) Anthracene		278	1500	0.480	4.80E-07	1.74E-09	< 39.0
Benzo (g,h,i) perylene		276	1500	0.480	4.80E-07	1.74E-09	< 39.0
Total				11402.33	1.14E-05	6.24E-08	1397.9

McClellan AFB		SVE Site		Event 1 SVOC's - Modified EPA Method 5/Method 8270				
PDT Outlet		12/20/95		PDT3S				
Date:		103.009		103.009				
Sample ID.								
Volume Sampled SCF								
Analyte	MW	Conc. Units	Micro-gms/liter	Micro-gms/M3	Gms/liter	Gm.moles/liter	Qualifier	ppb
1,1,1-Naphthlene	128	100	0.034	34.28	3.43E-08	2.68E-10	U	< 6.0
2-Methylnaphthalene	142	100	0.034	34.28	3.43E-08	2.41E-10	U	< 5.4
2-Chloronaphthalene	162	100	0.034	34.28	3.43E-08	2.12E-10	U	< 4.7
Acenaphthylene	152	100	0.034	34.28	3.43E-08	2.26E-10	U	< 5.1
Acenaphthene	154	100	0.034	34.28	3.43E-08	2.23E-10	U	< 5.0
Flourene	166	100	0.034	34.28	3.43E-08	2.07E-10	U	< 4.6
Phenanthrene	178	100	0.034	34.28	3.43E-08	1.93E-10	U	< 4.3
Anthracene	178	100	0.034	34.28	3.43E-08	1.93E-10	U	< 4.3
Flouranthene	202	100	0.034	34.28	3.43E-08	1.70E-10	U	< 3.8
Pyrene	202	100	0.034	34.28	3.43E-08	1.70E-10	U	< 3.8
Benzo (a) anthracene	228	100	0.034	34.28	3.43E-08	1.50E-10	U	< 3.4
Chrysene	228	100	0.034	34.28	3.43E-08	1.50E-10	U	< 3.4
Benzo(b)flouranthene	252	100	0.034	34.28	3.43E-08	1.36E-10	U	< 3.0
Benzo(k)flouranthene	252	100	0.034	34.28	3.43E-08	1.36E-10	U	< 3.0
Benzo(e)pyrene	252	100	0.034	34.28	3.43E-08	1.36E-10	U	< 3.0
Benzo(a)pyrene	252	100	0.034	34.28	3.43E-08	1.36E-10	U	< 3.0
Perylene	252	100	0.034	34.28	3.43E-08	1.36E-10	U	< 3.0
Indeno (1,2,3-cd) pyrene	276	100	0.034	34.28	3.43E-08	1.24E-10	U	< 2.8
Dibenz (a, h) Anthracene	278	100	0.034	34.28	3.43E-08	1.23E-10	U	< 2.8
Benzo (g,h,i) perylene	276	100	0.034	34.28	3.43E-08	1.24E-10	U	< 2.8
Total				685.68	6.86E-07	3.45E-09		< 77.3

McClellan AFB		SVE Site						
PTI Outlet		Event 2 SVOC's - Modified EPA Method 5/Method 8270						
Date:		12/21/95						
Sample ID:		PDT4S						
Volume Sampled SCF		110.4111						
Analyte	MW	Conc. Units	Micro.gms/liter	Micro.gms/M3	Gms/liter	Gm.moles/liter	Qualifier	ppb
1,1,1-Naphthlene	128	100	0.032	31.99	3.20E-08	2.50E-10	U	< 5.6
2-Methylnaphthalene	142	100	0.032	31.99	3.20E-08	2.25E-10	U	< 5.0
2-Chloronaphthalene	162	100	0.032	31.99	3.20E-08	1.97E-10	U	< 4.4
Acenaphthylene	152	100	0.032	31.99	3.20E-08	2.10E-10	U	< 4.7
Acenaphthene	154	100	0.032	31.99	3.20E-08	2.08E-10	U	< 4.7
Flourene	166	100	0.032	31.99	3.20E-08	1.93E-10	U	< 4.3
Phenanthrene	178	100	0.032	31.99	3.20E-08	1.80E-10	U	< 4.0
Anthracene	178	100	0.032	31.99	3.20E-08	1.80E-10	U	< 4.0
Flouranthene	202	100	0.032	31.99	3.20E-08	1.58E-10	U	< 3.5
Pyrene	202	100	0.032	31.99	3.20E-08	1.58E-10	U	< 3.5
Benzo (a) anthracene	228	100	0.032	31.99	3.20E-08	1.40E-10	U	< 3.1
Chrysene	228	100	0.032	31.99	3.20E-08	1.40E-10	U	< 3.1
Benzo(b)flouranthene	252	100	0.032	31.99	3.20E-08	1.27E-10	U	< 2.8
Benzo(k)flouranthene	252	100	0.032	31.99	3.20E-08	1.27E-10	U	< 2.8
Benzo(e)pyrene	252	100	0.032	31.99	3.20E-08	1.27E-10	U	< 2.8
Benzo(a)pyrene	252	100	0.032	31.99	3.20E-08	1.27E-10	U	< 2.8
Perylene	252	100	0.032	31.99	3.20E-08	1.27E-10	U	< 2.8
Indeno (1,2,3-cd) pyrene	276	100	0.032	31.99	3.20E-08	1.16E-10	U	< 2.6
Dibenz (a, h) Anthracene	278	100	0.032	31.99	3.20E-08	1.15E-10	U	< 2.6
Benzo (g,h,i) perylene	276	100	0.032	31.99	3.20E-08	1.16E-10	U	< 2.6
Total				639.71	6.40E-07	3.22E-09		< 72.2

McClellan AFB		SVE Site		Events 1 & 2 SVOC's - Modified EPA Method 5/Method 8270				
Sample Blank		1/15/96		SBLK				
Date:		SBLK		100				
Sample ID.		SBLK						
Volume Sampled SCF		100						
Analyte	MW	Conc. Units	Micro.gms/liter	Micro.gms/M3	Gms/liter	Gm.moles/liter	Qualifier	ppb
1,1,1-Naphthilene	128	ug	0.004	3.53	3.53E-09	2.76E-11	U	< 0.6
2-Methylnaphthalene	142	10	0.004	3.53	3.53E-09	2.49E-11	U	< 0.6
2-Chloronaphthalene	162	10	0.004	3.53	3.53E-09	2.18E-11	U	< 0.5
Acenaphthylene	152	10	0.004	3.53	3.53E-09	2.32E-11	U	< 0.5
Acenaphthene	154	10	0.004	3.53	3.53E-09	2.29E-11	U	< 0.5
Flourene	166	10	0.004	3.53	3.53E-09	2.13E-11	U	< 0.5
Phenanthrene	178	10	0.004	3.53	3.53E-09	1.98E-11	U	< 0.4
Anthracene	178	10	0.004	3.53	3.53E-09	1.98E-11	U	< 0.4
Flouranthene	202	10	0.004	3.53	3.53E-09	1.75E-11	U	< 0.4
Pyrene	202	10	0.004	3.53	3.53E-09	1.75E-11	U	< 0.4
Benzo (a) anthracene	228	10	0.004	3.53	3.53E-09	1.55E-11	U	< 0.3
Chrysene	228	10	0.004	3.53	3.53E-09	1.55E-11	U	< 0.3
Benzo(b)flouranthene	252	10	0.004	3.53	3.53E-09	1.40E-11	U	< 0.3
Benzo(k)flouranthene	252	10	0.004	3.53	3.53E-09	1.40E-11	U	< 0.3
Benzo(e)pyrene	252	10	0.004	3.53	3.53E-09	1.40E-11	U	< 0.3
Benzo(a)pyrene	252	10	0.004	3.53	3.53E-09	1.40E-11	U	< 0.3
Perylene	252	10	0.004	3.53	3.53E-09	1.40E-11	U	< 0.3
Indeno (1,2,3-cd) pyrene	276	10	0.004	3.53	3.53E-09	1.28E-11	U	< 0.3
Dibenz (a, h) Anthracene	278	10	0.004	3.53	3.53E-09	1.27E-11	U	< 0.3
Benzo (g,h,i) perylene	276	10	0.004	3.53	3.53E-09	1.28E-11	U	< 0.3
Total				70.63	7.06E-08	3.56E-10		< 8.0

McClellan AFB SVE Site S PTI

Pollutant Acetone

Date: 11/30/95

Sample ID:

INLET

PDT-01IT01

PDT-01IT02

P Baro.(in. Hg):

30.12

Weight of Acetone (ug)

865.000

38.7 **

Total weight of Acetone (ug)

903.700

Sample Rate (l/min)

0.264

Time Sampled (min)

20.5

Meter Temp.(R):

530

Sample Volume (L)

5.43

Acetone Conc.(ug/l)

166.50

Acetone Molecular wt.

58.00

Acetone Conc.(ppmv)

73.71

**Tube 2 sample weight.

McClellan AFB SVE Site S PTI

Pollutant **Acetone**

Date: **11/3095**

Sample ID:

P Baro.(in. Hg):

Weight of Acetone (ug):

Total weight of Acetone (ug)

Sample Rate (l/min)

Time Sampled (min)

Meter Temp.(R):

Sample Volume (L)

Acetone Conc.(ug/l)

Acetone Molecular wt.

Acetone Conc.(ppmv)

OUTLET

PDT-01OT01

PDT-01OT02

29.796

2.200

ND

2.200

0.506

20

530

10.04

0.22

58.00

0.10

ND = Non detect

McClellan AFB SVE Site S PTI

Pollutant Acetone

Date: 12/6/95

INLET

Sample ID:

CIPDT-AT1-03

P Baro.(in. Hg): 30.05

Weight of Acetone (ug) 1243.100

12.42 **

Total weight of Acetone (ug) 1230.680

Sample Rate (l/min) 0.2493

Time Sampled (min) 20

Meter Temp.(R): 523

Sample Volume (L) 5.06

Acetone Conc.(ug/l) 243.43

Acetone Molecular wt. 58.00

Acetone Conc.(ppmv) 107.76

**Equipment & Trip Blank Correction

McClellan AFB SVE Site S PTI

Pollutant Acetone

Date: 12/06/95

Sample ID:

OUTLET
PDT-AT1-02

P Baro.(in. Hg):	30.05
Weight of Acetone (ug) tube 1+2	175.330 **
Field Blank (ug)	9.500
Total weight of Acetone (ug)	165.830
Sample Rate (l/min)	0.505
Time Sampled (min)	15
Meter Temp.(R):	530
Sample Volume (L)	7.58
Acetone Conc.(ug/l)	21.88
Acetone Molecular wt.	58.00
Acetone Conc.(ppmv)	9.06

**H₂O = 112, Tube 1 = 59.4, Tube 2 = 3.93

McClellan AFB SVE Site S PTI

Pollutant **Acetone**

Date: **12/15/95**

Sample ID:

OUTLET
PDT-3T

P Baro.(in. Hg):	30.18
Weight of Acetone (ug) tube 1+H ₂ O Fraction	328.000
Total weight of Acetone (ug)	328.000
Sample Rate (l/min)	0.502
Time Sampled (min)	20
Meter Temp.(R):	519
Sample Volume (L)	10.30
Acetone Conc.(ug/l)	31.84
Acetone Molecular wt.	58.00
Acetone Conc.(ppmv)	13.18

PTI & ENV Source Testing Methods and Modifications

TO: Rajeev Krishnan
FROM: Landon Collom
DATE: January 29, 1996

CH2M HILL conducted testing for hydrogen chloride (HCl), nitrogen oxide (NO_x), ozone (O₃), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (dioxins), semivolatile organic compounds (SVOCs) and acetone. A brief narrative for each method and modifications follows.

EPA Method 26A (HCl). This method was used for the collection and recovery of the sample with the following exception. Because of the size of the exhaust ducts (3/4 inch), isokinetic testing was not performed. A sample rate of 0.4 to 0.6 cfm was used. A minimum of 30 dscf was collected for each sample run. Potential interferents included volatile materials such as chlorine dioxide and ammonium chloride, which produced halide ions upon dissolving during sampling. High concentrations of NO_x may produce sufficient nitrate to interfere with measurements of very low bromine levels.

EPA Method 7D (NO_x). This method was used for collection and recovery of samples for the first sampling event. After interpretation of the sampling results from the first event, sample recovery techniques were modified for all subsequent sampling events, to maximize detection limits. Each impinger was recovered separately and analyzed separately, without first diluting the samples to one liter. The results were then corrected for solution volumes and added together to determine total concentration. No other modifications were made. Possible interferences are sulfur dioxide and ammonia.

NIOSH Method S8 (O₃). This method was used for the first sampling event, but was modified after seeing the analysis results from the first event. Interpretation of the results concluded that sample breakthrough might have occurred. A series of three impingers were employed thereafter and each impinger was analyzed separately to determine if breakthrough had occurred. The sample recovery procedure was also modified to accommodate shipping requirements. The contents of the impingers were transferred to pre-tarred 40 mil VOA vials and then weighed before transport to the laboratory. The results from the three impingers were then added to determine total concentration. No other modifications were made. It should be noted that chlorine, hydrogen peroxide, organic peroxides, and various other oxidants will liberate iodine by this method. Other interferences are nitrogen dioxide and reducing gases such as hydrogen sulfide.

EPA Method 23 (Dioxins). This method was used for collection and recovery of the sample with the following exception. Because of the size of exhaust ducting (3/4 inch), non-isokinetic testing was conducted. A sample rate of 0.4 to 0.6 cfm was maintained until a minimum of 30 dscf was collected. Because of unknown concentrations in the exhaust stream, some runs collected a minimum of 60 dscf to lower detection limits.

CARB Method 0010 (SVOCs). This method was used for collection and recovery of the sample except as noted above. Because of duct size, isokinetic sampling could not be conducted. A minimum of 106 dscf of sample was collected at a rate of 0.4 to 0.6 cfm. It should be noted that the results of this testing may have a negative bias because of high NO_x concentrations in some of the sample results. Each sample result should be compared to the counterpart test results for NO_x .

NIOSH Method 1300 (Acetone). This method was used for collection and recovery of the sample with the following exception. After interpretation of the data from the first sampling event, a chilled impinger with 10 ml of deionized water was added inline before the absorbent tubes. This addition prevented sample channeling in the absorbent tubes and allowed for sample breakthrough caused by unknown sample stream concentrations. A blank of the deionized water was taken and analyzed for QA/QC. In one case, a correction for this blank was subtracted from the sample results (CISDPTAT103). The impinger catch was weighed and then transferred to a 40 ml VOA vial for transport to the laboratory for analysis for acetone. These results were corrected for volume and were then added to the tube results to obtain a total concentration.

HCI/HF Results

McClellan AFB
Innovative Offgas Demonstration
PDT Outlet
HCL/HF Test Results

Date	Sample ID	Sample Volume (ml)	Density of Water at Avg. Temp. (g/ml)	Sample Wt (g)	Sample Results (mg/l)		Vm (ft3)	Yd	Barometric Pressure (in. Hg)	Avg. Tm (oF)	Time (min)	Vstd (ft3)	Vstd (L)	HCl Concentration (ug/M3)		HF Concentration (ppmv)	
					HCl as Cl	HF as F								(ug/M3)	(ppmv)	(ug/M3)	(ppmv)
11/30/95	PDT-1H-01	431.66	0.99901	431.23	5.6	1.3	35.040	0.998	29.92	80.7	72.4	34.13	966.60	2,549	1.7	606	0.7
12/1/95	PDT-2H-021	492.51	0.99901	492.02	12.8	1.8	38.610	0.998	29.92	61.9	67	38.96	1103.45	5,876	3.9	846	1.0
12/14/95	PDT-3H-311	494.29	0.99901	493.8	30.9	1.7	33.79	0.998	30.28	59.4	72	34.67	981.90	15,998	10.6	880	1.1
12/14/95	PDT-3H-312	456.86	0.99901	456.41	36.2	2.7	31.96	0.998	30.28	67.0	72	32.33	915.47	18,580	12.3	1,397	1.7

Example Calculation ID. PDT-1H-01

Vstd(FT3)= 35.04*(29.92/29.92)*[528/(80.7+460)]*.9975

HCl (ug/m3) 5.55*431.66*36.46/(35.45*966.6*0.001)

HCl (PPMV) 2549/1000/36.46*24.05

HF (ug/m3) 1.29*431.66*20/(19*966.6*0.001)

HF (PPMV) 606/1000/20*24.05

NO_x Results

McClellan AFB

NOx Emission Calculations

Sample ID. PDT1N & PDT2N

Date: 12/1/95 & 12/2/95

By: Landon Collom

Sample Identity	PDT1N	PDT2N	Average
Vm, sample @ meter cond., ft ³	0.968	3.369	
Tm, meter temp., °F	66	74	
Bp, barometric pressure, "Hg	30.1	30.17	
CO ₂ , percent carbon dioxide, %	2.04	2.04	
Yd, dry gas meter factor	0.979	0.979	
Vs, sample vol. @ std. cond., ft ³	0.977	3.357	
Qs, stack gas flowrate, sdcfm	10	10	
Sc, sample sol. conc. NO ₂ -N, ug/l	54.1	78.3	
Bc, blank sol. conc. NO ₂ -N, ug/l	47.1	54.8	
Sv, impinger sol. vol, mls	793.56	818.1	
Bv, blank sol. vol., mls	503.38	326.26	
Sm, sample results, ug	42.9	54.8	
Bm, blank results, ug	23.7	17.9	
Conc. NOx-NO ₂ , mg/M ³	11.42	6.38	
Conc. NOx-NO ₂ , ppmv	5.97	3.34	4.65
Conc. NOx-NO ₂ , lbs/ft ³	7.12E-07	3.98E-07	5.55E-07

Where:

$$\text{Conc. NOx} - \text{NO}_2, \text{mg} / \text{M}^3 = \frac{(S_m - B_m) * \frac{250 \text{ml}}{50 \text{ml}} * \frac{46.01}{14.01} * \frac{1 \text{mg}}{1000 \text{ug}}}{V_s}$$

$$\text{Conc. NOx} - \text{NO}_2, \text{ppmv} = \frac{\text{mg} / \text{M}^3}{1.912}$$

$$\text{Conc. NOx} - \text{NO}_2, \text{lbs} / \text{ft}^3 = \frac{\text{mg}}{\text{M}^3} * 6.237 \times 10^{-8}$$

$$\text{EmissionRate NOx} - \text{NO}_2, \text{lbs} / \text{hr} = \frac{\text{lbs}}{\text{ft}^3} * Q_s * \frac{60 \text{min}}{\text{hr}}$$

McClellan AFB**NOx Emission Calculations****Sample ID. PDT1N121 &PDT2N121****By: Landon Collom**

Sample Identity	PDT1N121	PDT2N121	Average
Sample Collection date	12/14/95	12/14/95	
Vm, volume @ meter cond., ft ³	0.988	2.895	
Tm, meter temp., °F	60	57	
Bp, barometric pressure, "Hg	30.28	30.18	
CO ₂ , percent carbon dioxide, %	2.65	2.65	
Yd, dry gas meter factor	0.979	0.979	
Vs, sample vol. @ std. cond., ft ³	1.0210	2.9991	
Qs, stack gas flowrate, scfm	10	10	
Sc ₁ , 1st impinger sol. conc. NO ₃ -N, ug/l	56.7	86.2	
Sc ₂ , 2nd impinger sol. conc. NO ₃ -N, ug/l	53.9	56.6	
Sc ₃ , 3rd impinger sol. conc. NO ₃ -N, ug/l	54.5	73.4	
Bc, blank sol. conc. NO ₃ -N, ug/l	64	64	
SV ₁ , 1st impinger sol. vol, mls	244.41	270.42	
SV ₂ , 2nd impinger sol. vol, mls	257.89	270.2	
SV ₃ , 3rd impinger sol. vol, mls	267.05	256.01	
Bv, blank sol. vol., mls	209.5	209.5	
Sm, sample results, ug	42.3	57.4	
Bm, blank results, ug	40.2	40.2	
Conc. NOx-NO ₂ , mg/M ³	1.19	3.32	2.25
Conc. NOx-NO ₂ , ppmv	0.62	1.74	1.18
Conc. NOx-NO ₂ , lbs/ft ³	7.40E-08	2.07E-07	1.41E-07

McClellan AFB

NOx Emission Calculations

Sample ID. PDT1N121 & PDT2N121

By: Landon Collom

Where:

$$\text{Conc. NOx} - \text{NO}_2, \text{mg} / \text{M}^3 = \frac{(\text{Sm} - \text{Bm}) * \frac{250\text{ml}}{50\text{ml}} * \frac{46.01}{14.01} * \frac{1\text{mg}}{1000\text{ug}}}{V_s}$$

$$\text{Conc. NOx} - \text{NO}_2, \text{ppmv} = \frac{\text{mg} / \text{M}^3}{1.912}$$

$$\text{Conc. NOx} - \text{NO}_2, \text{lbs} / \text{ft}^3 = \frac{\text{mg}}{\text{M}^3} * 6.237 \times 10^{-8}$$

$$\text{EmissionRateNOx} - \text{NO}_2, \text{lbs} / \text{hr} = \frac{\text{lbs}}{\text{ft}^3} * Q_s * \frac{60 \text{ min}}{\text{hr}}$$

Phosgene Results

Phosgene Sampling

TO: Rajeev Krishnan/CVO
FROM: Chris Goodrich/McClellan trailer
COPY: Al Davis/CVO
DATE: January 10, 1996

There were four offgas sampling events during the technology demonstration that were used to determine if phosgene was present in either of the two technologies' offgas. The method used to determine the presence of phosgene was a direct read instrument using Draeger Grab Sample Phosgene (color) Detector Tubes capable of measuring phosgene concentrations in the range of .025 to 75 parts per million (ppm).

These sample events were conducted per table SAP-2 of the Sampling and Analysis Plan contained in the *Final Demonstration Work Plan Environmental Management of Offgas Technology* under Delivery Order 7036, Item No. D005, Paragraph 7.2.6. However, the dates of the events do not coincide with the work plan because the operational frequency of the technologies did not coincide with the work plan.

The results for each of the sampling events showed that there was no detectable amount of phosgene present in either of the technologies' offgas streams. The table below shows the results and operating parameters for each sampling event.

Date	Technology	Flow Rate	Pressure	Temperature	Results
12-20-95	PTI	10 cfm	4" H ₂ O	145°F	nondetect
12-21-95	PTI	10 cfm	4" H ₂ O	145°F	nondetect
12-28-95	ENV	5.0 cfm	3" H ₂ O	32.5°C	nondetect
1-10-96	ENV	2.8 cfm	-3" H ₂ O	34.7°F	nondetect

Ozone Results

McClellan AFB
Innovative Offgas Demonstration
PDT Outlet
Ozone Test Results

Date	Sample ID	Sample Volume (std/liters)	Sample Conc. ug/l	Sample Wt (ug)	Sample Rate (lpm)	Sample Time Minutes	Barometric Pressure (in. Hg)	Avg. Tm (F)	Ozone Concentration	
									(ug/m3)	(ppmv)
12/2/95	PDT1RZ1	45.69	4.36	199	1.0125	45	29.95	66.0	4355.4456	2.1823
12/2/95	PDT2RZ1	47.25	3.89	184	1.0265	45	29.70	60.0	3894.1317	1.9511
12/22/95	PDT1R2Z1	47.56	7.82	371.9	1	46	30.08	48.0	7820.1373	3.9182
12/22/95	PDT2R2Z1	41.97	1.47	61.78	0.903	45	30.11	48.0	1472.0637	0.7376
12/22/95	PDT3R2Z1	49.23	1.20	58.95	0.995	48	30.05	50.0	1197.3983	0.5999

(Std/L)= LPM * Minutes * 528 / (Temp F + 460)*29.92/BP

(UG/M^3) ug/l * 1000

(UG/L)= ug / std/liters

(PPMV)= (ug/m^3)/1000/48*24.05

Dioxin Results

McClellan Air Force Base, PDT Stack Testing

Using CAPCOA TCDD Equivalency Factors

Client ID: PDT-2D Vol dscf 55.9300 Matrix (Analysis): Air (Method 23)
 Lab ID: W359208 Flow dscfm 10.000 Date Sampled: 12/6/95

RAW DATA

Parameter	Result (ng)	Detection Limit (ng)	Data Qualifier(s)
FURANS			
TCDFs (total)	0.2	-	-
2,3,7,8-TCDF	0.02	-	-
PeCDFs (total)	0.06	-	-
1,2,3,7,8-PeCDF	0.009	-	-
2,3,4,7,8-PeCDF	0.007	-	-
HxCDFs (total)	0.04	-	-
1,2,3,4,7,8-HxCDF	0.01	-	-
1,2,3,6,7,8-HxCDF	0.003	-	-
2,3,4,6,7,8-HxCDF	0.01	-	U
1,2,3,7,8,9-HxCDF	ND	0.004	-
HpCDFs (total)	ND	0.01	-
1,2,3,4,6,7,8-HpCDF	ND	0.01	-
1,2,3,4,7,8,9-HpCDF	ND	0.006	-
OCDF	ND	0.02	-
DIOXINS			
TCDDs (total)	0.66	-	-
2,3,7,8-TCDD	ND	0.004	-
PeCDDs (total)	0.11	-	-
1,2,3,7,8-PeCDD	ND	0.005	-
HxCDDs (total)	0.04	-	-
1,2,3,4,7,8-HxCDD	ND	0.004	-
1,2,3,6,7,8-HxCDD	ND	0.006	-
1,2,3,7,8,9-HxCDD	ND	0.006	-
HpCDDs (total)	0.06	-	U
1,2,3,4,6,7,8-HpCDD	0.03	-	U
OCDD	0.09	-	U

ND = Not Detected * = Blank Contamination EMPC = Est. Max. Possible Conc.

2,3,7,8 TCDD EQUIVALENTS

Analyte(s)	Potency Relative to 2,3,7,8-TCDD	Concentration (ng)	Detection Limit (ng)	Conc. ng/m3	Emission Rate (lb/hr)	1-TEFs/89 TCDD Equiv. (ng)
DIOXINS						
2,3,7,8-TCDD	1	ND	0.004	0	0	0
1,2,3,7,8-PeCDD	1	ND	0.005	0	0	0
2,3,7,8-HxCDD	0.03	ND	0.004	0	0	0
2,3,7,8-HpCDD	0.03	0.03	-	0.00056826	2.1266E-14	0.0009
OCDDs	0	0.09	-	0	0	0
FURANS						
2,3,7,8-TCDF	1	0.02	-	0.0126281	4.7259E-13	0.02
1,2,3,7,8-PeCDF	1	0.009	-	0.00568264	2.1266E-13	0.009
2,3,4,7,8-PeCDF	1	0.007	-	0.00441983	1.654E-13	0.007
2,3,7,8-HxCDF	0.03	0.023	0.004	0.00043567	1.6304E-14	0.00069
2,3,7,8-HpCDF	0.03	ND	0.006	0	0	0
OCDFs	0	ND	0.02	0	0	0
TOTAL TCDD EQUIVALENTS				0.02373431	8.8822E-13	0.038

Total TCDD Equivalents (ng) 0.038

McClellan Air Force Base, PDT Stack Testing Using CAPCOA TCDD Equivalency Factors

Client ID: PDT-1D Vol dscf 28.3450 Matrix (Analysis): Air (Method 23)
Lab ID: W359207 Flow dscfm 10.000 Date Sampled: 12/6/95

RAW DATA

Parameter	Result (ng)	Detection Limit (ng)	Data Qualifier(s)
FURANS			
TCDFs (total)	0.15	-	-
2,3,7,8-TCDF	0.02	-	-
PeCDFs (total)	0.05	-	-
1,2,3,7,8-PeCDF	0.006	-	-
2,3,4,7,8-PeCDF	ND	0.008	-
HxCDFs (total)	0.04	-	-
1,2,3,4,7,8-HxCDF	0.02	-	-
1,2,3,6,7,8-HxCDF	ND	0.005	-
2,3,4,6,7,8-HxCDF	0.01	-	U
1,2,3,7,8,9-HxCDF	ND	0.004	-
HpCDFs (total)	ND	0.02	-
1,2,3,4,6,7,8-HpCDF	ND	0.01	-
1,2,3,4,7,8,9-HpCDF	ND	0.005	-
OCDF	0.01	-	U
DIOXINS			
TCDDs (total)	0.42	-	-
2,3,7,8-TCDD	ND	0.004	-
PeCDDs (total)	0.13	-	-
1,2,3,7,8-PeCDD	ND	0.004	-
HxCDDs (total)	0.13	-	-
1,2,3,4,7,8-HxCDD	0.005	-	-
1,2,3,6,7,8-HxCDD	0.01	-	-
1,2,3,7,8,9-HxCDD	ND	0.005	-
HpCDDs (total)	0.09	-	U
1,2,3,4,6,7,8-HpCDD	0.05	-	U
OCDD	0.1	-	U

ND = Not Detected * = Blank Contamination EMPC = Est. Max. Possible Conc.

2,3,7,8 TCDD EQUIVALENTS

Analyte(s)	Potency Relative to 2,3,7,8-TCDD	Concentration (ng)	Detection Limit (ng)	Conc. ng/m3	Emission Rate (lb/hr)	I-TEFs/89 TCDD Equiv. (ng)
DIOXINS						
2,3,7,8-TCDD	1	ND	0.004	0	0	0
2,3,7,8-PeCDD	1	ND	0.004	0	0	0
2,3,7,8-HxCDD	0.03	0.015	0.005	0.00056065	2.0981E-14	0.00045
2,3,7,8-HpCDD	0.03	0.05	-	0.00186882	6.9938E-14	0.0015
OCDDs	0	0.1	-	0	0	0
FURANS						
2,3,7,8-TCDF	1	0.02	-	0.0249176	9.325E-13	0.02
1,2,3,7,8-PeCDF	1	0.006	-	0.00747528	2.7975E-13	0.006
2,3,4,7,8-PeCDF	1	ND	0.008	0	0	0
2,3,7,8-HxCDF	0.03	0.03	0.004	0.00112129	4.1963E-14	0.0009
2,3,7,8-HpCDF	0.03	ND	0.005	0	0	0
OCDFs	0	0.01	-	0	0	0
TOTAL TCDD EQUIVALENTS				0.03594364	1.3451E-12	0.029

Total TCDD Equivalents (ng) 0.029

TICs for VOCs and SVOCs



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: COMOSC04
LAB ID: 115904-0001-SA
Matrix: AIR
Authorized: 14 NOV 95
Instrument: GC/MS-A

Sampled: 13 NOV 95
Prepared: N/A
Dilution: 400

Received: 14 NOV 95
Analyzed: 17 NOV 95

Parameter	Result	Qualifier	RL	Units
Alkane substituted cycloalkane (C9)	4800	J	--	ppb (v/v)
Alkane substituted cycloalkane (C9)	3200	J	--	ppb (v/v)
Alkane substituted cycloalkane (C9)	20000	J	--	ppb (v/v)
Alkene (C10)	8000	J	--	ppb (v/v)
Alkene (C11)	11000	J	--	ppb (v/v)
Branched alkane (C10)	5200	J	--	ppb (v/v)
Branched alkane (C11)	15000	J	--	ppb (v/v)
Decane	16000	J	--	ppb (v/v)
Nonane	8800	J	--	ppb (v/v)
Octane	3200	J	--	ppb (v/v)
Unsaturated hydrocarbon (C11)	5600	J	--	ppb (v/v)
Unsaturated hydrocarbon (C9)	7200	J	--	ppb (v/v)

BM
12-13-95

J = Result is detected below the reporting limit or is an estimated concentration.



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: PDTC04
LAB ID: 115904-0003-SA
Matrix: AIR
Authorized: 14 NOV 95
Instrument: GC/MS-A

Sampled: 13 NOV 95
Prepared: N/A
Dilution: 190

Received: 14 NOV 95
Analyzed: 17 NOV 95

Parameter	Result	Qualifier	RL	Units
No Peaks Found	--	--		ppb (v/v)

DM
12-13-95



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: COMOS-C07
LAB ID: 116071-0001-SA
Matrix: AIR
Authorized: 21 NOV 95
Instrument: GC/MS-A

Sampled: 20 NOV 95
Prepared: N/A
Dilution: 1000

Received: 21 NOV 95
Analyzed: 01 DEC 95

Parameter	Result	Qualifier	RL	Units
Alkane substituted cycloalkane (C10)	18000	J	--	ppb (v/v)
Alkane substituted cycloalkane (C11)	7000	J	--	ppb (v/v)
Alkane substituted cycloalkane (C9)	8000	J	--	ppb (v/v)
Alkene (C10)	7000	J	--	ppb (v/v)
Branched alkane (C11)	6000	J	--	ppb (v/v)
Branched alkane (C11)	10000	J	--	ppb (v/v)
Branched alkene (C11)	13000	J	--	ppb (v/v)
Decane	14000	J	--	ppb (v/v)
No Match Found	7000	J	--	ppb (v/v)
Nonane	9000	J	--	ppb (v/v)

mm
1-8-96

J = Result is detected below the reporting limit or is an estimated concentration.



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: PDT-C06
LAB ID: 116071-0002-SA
Matrix: AIR
Authorized: 21 NOV 95
Instrument: GC/MS-A

Sampled: 20 NOV 95
Prepared: N/A
Dilution: 270

Received: 21 NOV 95
Analyzed: 01 DEC 95

Parameter	Result	Qualifier	RL	Units
No Peaks Found	--		--	ppb (v/v)

DM
1-8-96



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: COMOS-C10
LAB ID: 116187-0001-SA
Matrix: AIR
Authorized: 01 DEC 95
Instrument: GC/MS-B

Sampled: 30 NOV 95
Prepared: N/A
Dilution: 980

Received: 01 DEC 95
Analyzed: 13 DEC 95

Parameter	Result	Qualifier	RL	Units
Alkane substituted benzene (C9)	9800	J	--	ppb (v/v)
Alkane substituted cycloalkane (C10)	40000	J	--	ppb (v/v)
Alkane substituted cycloalkane (C9)	8800	J	--	ppb (v/v)
Alkene (C10)	38000	J	--	ppb (v/v)
Branched Alkene (C10)	9800	J	--	ppb (v/v)
Decane	25000	J	--	ppb (v/v)
Nonane	19000	J	--	ppb (v/v)
Oxygenated alkene (C9)	8800	J	--	ppb (v/v)
Oxygenated alkene substituted cycloalkane (C9)	14000	J	--	ppb (v/v)
Oxygenated branched alkene (C9)	9800	J	--	ppb (v/v)

J = Result is detected below the reporting limit or is an estimated concentration.



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: PDT-C10
LAB ID: 116187-0002-SA
Matrix: AIR
Authorized: 01 DEC 95
Instrument: GC/MS-B

Sampled: 30 NOV 95
Prepared: N/A
Dilution: 120

Received: 01 DEC 95
Analyzed: 13 DEC 95

Parameter	Result	Qualifier	RL	Units
No Peaks Found	--	--		ppb (v/v)

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: COMOS-C12
LAB ID: 116303-0001-SA
Matrix: AIR
Authorized: 08 DEC 95
Instrument: GC/MS-B

Sampled: 07 DEC 95
Prepared: N/A
Dilution: 920

Received: 08 DEC 95
Analyzed: 18 DEC 95

Parameter	Result	Qualifier	RL	Units
Alkane substituted cycloalkane (C10)	27000	J	--	ppb (v/v)
Alkane substituted cycloalkane (C10)	6500	J	--	ppb (v/v)
Alkane substituted cycloalkane (C9)	6500	J	--	ppb (v/v)
Branched alkene (C9)	24000	J	--	ppb (v/v)
Decane	18000	J	--	ppb (v/v)
Di-alkene (C9)	9200	J	--	ppb (v/v)
Di-alkene (C9)	5500	J	--	ppb (v/v)
Nitrogen substituted alkane (C8)	7400	J	--	ppb (v/v)
Nonane	12000	J	--	ppb (v/v)

J = Result is detected below the reporting limit or is an estimated concentration.



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: PDT-C12
LAB ID: 116303-0002-SA
Matrix: AIR
Authorized: 08 DEC 95
Instrument: GC/MS-B

Sampled: 07 DEC 95
Prepared: N/A
Dilution: 190

Received: 08 DEC 95
Analyzed: 18 DEC 95

Parameter	Result	Qualifier	RL	Units
No Peaks Found	--		--	ppb (v/v)



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: COMOS-C14
LAB ID: 116431-0005-SA
Matrix: AIR
Authorized: 15 DEC 95
Instrument: GC/MS-A

Sampled: 14 DEC 95
Prepared: N/A
Dilution: 830

Received: 15 DEC 95
Analyzed: 21 DEC 95

Parameter	Result	Qualifier	RL	Units
Alkane substituted cycloalkane (C9)	5000	J	--	ppb (v/v)
Branched alkene (C10)	25000	J	--	ppb (v/v)
Branched alkene (C8)	10000	J	--	ppb (v/v)
Branched alkene (C9)	9200	J	--	ppb (v/v)
Decane	22000	J	--	ppb (v/v)
Di-alkene (C11)	16000	J	--	ppb (v/v)
Nonane	12000	J	--	ppb (v/v)
Oxygenated alkene (C9)	10000	J	--	ppb (v/v)
Unknown	8300	J	--	ppb (v/v)

J = Result is detected below the reporting limit or is an estimated concentration.



Tentatively Identified Compounds (TICs)
Method EPA TO-14

Environmental
Services

Client Name: CH2M Hill
Client ID: PDT-C14
LAB ID: 116431-0006-SA
Matrix: AIR
Authorized: 15 DEC 95
Instrument: GC/MS-A

Sampled: 14 DEC 95
Prepared: N/A
Dilution: 160

Received: 15 DEC 95
Analyzed: 21 DEC 95

Parameter	Result	Qualifier	RL	Units
No Peaks Found	--		--	ppb (v/v)

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: COMOS-C16
LAB ID: 116494-0001-SA
Matrix: AIR
Authorized: 20 DEC 95
Instrument: GC/MS-A

Sampled: 19 DEC 95
Prepared: N/A
Dilution: 690

Received: 20 DEC 95
Analyzed: 29 DEC 95

Parameter	Result	Qualifier	RL	Units
Alkane substituted cycloalkane (C10)	28000	J	--	ppb (v/v)
Alkane substituted cycloalkane (C10)	9000	J	--	ppb (v/v)
Alkane substituted cycloalkane (C9)	9700	J	--	ppb (v/v)
Alkane substituted cycloalkane (C9)	3500	J	--	ppb (v/v)
Alkane substituted cycloalkane (C9)	27000	J	--	ppb (v/v)
Alkene (C9)	3500	J	--	ppb (v/v)
Di-alkene (C9)	9700	J	--	ppb (v/v)
Nonane	11000	J	--	ppb (v/v)
Octane	4100	J	--	ppb (v/v)
Oxygenated alkene (C9)	9700	J	--	ppb (v/v)

J = Result is detected below the reporting limit or is an estimated concentration.

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: PDT-C16
LAB ID: 116494-0002-SA
Matrix: AIR
Authorized: 20 DEC 95
Instrument: GC/MS-A

Sampled: 19 DEC 95
Prepared: N/A
Dilution: 180

Received: 20 DEC 95
Analyzed: 29 DEC 95

Parameter	Result	Qualifier	RL	Units
No Peaks Found	--		--	ppb (v/v)

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: COMOS-C17
LAB ID: 116645-0001-SA
Matrix: AIR
Authorized: 05 JAN 96
Instrument: GC/MS-B

Sampled: 04 JAN 96
Prepared: N/A
Dilution: 820

Received: 05 JAN 96
Analyzed: 15 JAN 96

Parameter	Result	Qualifier	RL	Units
Alkane (C11)	9800	J	--	ppb (v/v)
Alkane substituted cycloalkane (C10)	4100	J	--	ppb (v/v)
Alkane substituted cycloalkane (C8)	8200	J	--	ppb (v/v)
Alkane substituted cycloalkane (C9)	4900	J	--	ppb (v/v)
Branched Alkene (C10)	23000	J	--	ppb (v/v)
Decane	16000	J	--	ppb (v/v)
Di-alkene (C9)	7400	J	--	ppb (v/v)
No Match Found	6500	J	--	ppb (v/v)
Nonane	12000	J	--	ppb (v/v)
Oxygenated alkane (C8)	22000	J	--	ppb (v/v)

J = Result is detected below the reporting limit or is an estimated concentration.



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: PDT-C17
LAB ID: 116645-0002-SA
Matrix: AIR
Authorized: 05 JAN 96
Instrument: GC/MS-B

Sampled: 04 JAN 96
Prepared: N/A
Dilution: 170

Received: 05 JAN 96
Analyzed: 15 JAN 96

Parameter	Result	Qualifier	RL	Units
Alkane (C11)	3100	J	--	ppb (v/v)
Alkane substituted benzene (C9)	850	J	--	ppb (v/v)
Alkane substituted cycloalkane (C10)	2200	J	--	ppb (v/v)
Alkene (C11)	1000	J	--	ppb (v/v)
Branched alkane (C10)	1000	J	--	ppb (v/v)
Decane	2700	J	--	ppb (v/v)
Di-alkene (C10)	1500	J	--	ppb (v/v)
Nitrogen substituted alkane (C7)	1900	J	--	ppb (v/v)
No Match Found	1000	J	--	ppb (v/v)

J = Result is detected below the reporting limit or is an estimated concentration.



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: COMOS-C18
LAB ID: 116728-0005-SA
Matrix: AIR
Authorized: 11 JAN 96
Instrument: GC/MS-B

Sampled: 10 JAN 96
Prepared: N/A
Dilution: 710

Received: 11 JAN 96
Analyzed: 16 JAN 96

Parameter	Result	Qualifier	RL	Units
Alkane substituted cycloalkane (C10)	9900	J	--	ppb (v/v)
Alkane substituted cycloalkane (C10)	28000	J	--	ppb (v/v)
Alkane substituted cycloalkane (C10)	5600	J	--	ppb (v/v)
Alkane substituted cycloalkane (C10)	5600	J	--	ppb (v/v)
Alkane substituted naphthalene (C10)	7800	J	--	ppb (v/v)
Alkene (C9)	26000	J	--	ppb (v/v)
Decane	19000	J	--	ppb (v/v)
Di-alkene (C9)	7100	J	--	ppb (v/v)
Nitrogen substituted alkane (C5)	7100	J	--	ppb (v/v)
Nonane	11000	J	--	ppb (v/v)

J = Result is detected below the reporting limit or is an estimated concentration.



Environmental
Services

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client Name: CH2M Hill
Client ID: PDT-C18
LAB ID: 116728-0006-SA
Matrix: AIR
Authorized: 11 JAN 96
Instrument: GC/MS-B

Sampled: 10 JAN 96
Prepared: N/A
Dilution: 51

Received: 11 JAN 96
Analyzed: 16 JAN 96

Parameter	Result	Qualifier	RL	Units
Alkane (C11)	760	J	--	ppb (v/v)
Alkane substituted cycloalkane (C10)	360	J	--	ppb (v/v)
Alkane substituted naphthalene (C10)	310	J	--	ppb (v/v)
Decane	460	J	--	ppb (v/v)
Unknown	310	J	--	ppb (v/v)
Unknown	250	J	--	ppb (v/v)

J = Result is detected below the reporting limit or is an estimated concentration.

CH2M HILL

Project Number: 35634
Sample File: VE923

Method 8270A
Sample ID CIPDT-5S-XAF,XAD,CH3,XM12

Client Project:	MCCLELLAN AFB	Date Received:	12/23/96
TLI ID:	112-39-3A-E	Date Extracted:	12/27/95
		Date Analyzed:	01/17/96
Dilution Factor:		150	

Tentatively Identified Compounds

Name	RT	Area	IS RT	IS Area	Amount, ug
trimethyl-Cyclohexane	8.344	8338827	16.877	2852281	17541
dimethyl-Benzene (xylene)	8.610	31602464	16.877	2852281	66478
substituted Cyclohexane	8.905	45010966	16.877	2852281	94684
Substituted cyclic hydrocarbon	9.150	67598465	16.877	2852281	142199
Substituted alkane	9.294	196494519	16.877	2852281	413342
ethyl-methyl-Benzene	9.806	111982336	16.877	2852281	235564
trimethyl-Benzene	10.383	154923032	16.877	2852281	325893
dichloro-Benzene	10.730	149611195	16.877	2852281	314719
dichloro-Benzene	11.092	236226464	16.877	2852281	496921
methyl-propyl-Benzene	11.215	41852691	16.877	2852281	88040
Substituted Benzene C10H14	11.302	40743796	16.877	2852281	85708
decahydro-Naphthalene	11.490	50795590	16.877	2852281	106853
Substituted Benzene C10H14	11.707	59352590	16.877	2852281	124853
Substituted Benzene C10H12	11.794	33943497	16.877	2852281	71403
Substituted Benzene	11.931	25067799	16.877	2852281	52732
ethyl-dimethyl-Benzene	12.011	11631045	16.877	2852281	24467
Substituted Benzene C10H12	12.177	8861854	16.877	2852281	18642
decahydro-methyl-Naphthalene	12.271	12348589	16.877	2852281	25976
decahydro-methyl-Naphthalene	12.495	13470418	16.877	2852281	28336
methyl-(methylene)-Benzene	12.683	8451573	16.877	2852281	17779

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08

Triangle Laboratories of RTP, Inc.
801 Capitola Drive * Durham, North Carolina 27713
Phone: (919) 544-5729 * Fax: (919) 544-5491

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CH2M HILL

Project Number: 35634

Method 8270A

Sample File: VE921

Sample ID PDT-3S-XAF,XAD,CH3,XM

Client Project: MCCLELLAN AFB

Date Received: 12/23/96

TLI ID: 112-39-1A-E

Date Extracted: 12/27/95

Date Analyzed: 01/17/96

Dilution Factor: 10

Tentatively Identified Compounds

Name	RT	Area	IS RT	IS Area	Amount, ug
oxygenated hydrocarbon	7.948	1510097	10.631	2590713	233
dichloro-2-Propanone	8.349	780553	10.631	2590713	121
Butyrolactone	8.837	698188	10.631	2590713	108
trichloro-methyl ester Acetic acid	8.908	801429	10.631	2590713	124
Substituted hydrocarbon	8.937	593169	10.631	2590713	92
tetrachloro-Ethane	9.023	1196920	10.631	2590713	185
Benzaldehyde	9.791	1457123	10.631	2590713	225
Unknown	9.942	624381	10.631	2590713	96
Substituted hydrocarbon	10.322	1448074	10.631	2590713	224
chlorinated hydrocarbon	10.746	707085	10.631	2590713	109
Benzyl Alcohol	10.882	870960	10.631	2590713	134
chlorinated hydrocarbon	11.033	727183	10.631	2590713	112
chlorinated hydrocarbon	11.220	967331	10.631	2590713	149
chlorinated hydrocarbon	11.738	2834314	13.198	5165585	219
chlorinated hydrocarbon	11.846	1852039	13.198	5165585	143
Substituted hydrocarbon	11.990	816546	13.198	5165585	63
Benzoic Acid	12.644	2463795	13.198	5165585	191
ethyl-Benzaldehyde	12.816	641282	13.198	5165585	50
Triacetin	14.779	827845	13.198	5165585	64
Benzophenone	18.379	344842	13.198	5165585	27

Triangle Laboratories of RTP, Inc.

801 Capitola Drive * Durham, North Carolina 27713

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02/08/96

CH2M HILL

Project Number: 35634
Sample File: VE922

Method 8270A
Sample ID PDT-4S-XAF,XAD,CH3,XMI,2

Client Project: MCCLELLAN AFB
TLI ID: 112-39-2A-E

Date Received: 12/23/96
Date Extracted: 12/27/95
Date Analyzed: 01/17/96

Dilution Factor: 10

Tentatively Identified Compounds

Name	RT	Area	IS RT	IS Area	Amount, ug
oxygenated hydrocarbon	7.946	994143	10.629	2513993	158
oxygenated hydrocarbon	8.490	356589	10.629	2513993	57
tetrachloro-Ethane	9.019	694994	10.629	2513993	111
chlorinated hydrocarbon	9.749	474903	10.629	2513993	76
Benzaldehyde	9.785	880905	10.629	2513993	140
octamethyl-Cyclotetrasiloxane	7.596	5024374	10.629	2513993	799
substituted hydrocarbon	10.314	393777	10.629	2513993	63
Chlorinated hydrocarbom	10.744	335833	10.629	2513993	53
Benzyl Alcohol	10.880	567899	10.629	2513993	90
chlorinated hydrocarbon	11.031	306493	10.629	2513993	49
pentachloro-2-Propanone	11.733	1264897	10.629	2513993	201
substituted hydrocarbon	11.992	328346	13.196	3244035	40
Benzoic Acid	12.651	2089654	13.196	3244035	258
ethyl-Benzaldehyde	12.816	631477	13.196	3244035	78
ethyl-Benzaldehyde	13.074	264464	13.196	3244035	33
diacetate-1,2,3-Propanetriol	13.598	343394	13.196	3244035	42
Substituted Heptatriene	13.713	938613	13.196	3244035	116
Triacetin	14.781	2155469	13.196	3244035	266
diethyl-phthalate	17.750	235550	13.196	3244035	29
Benzophenone	18.366	203529	13.196	3244035	25

Triangle Laboratories of RTP, Inc.

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Printed: 17:08 01/30/96

WH/. 02/08/96



**Sequoia
Analytical**

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404 N. Wiget Lane
819 Striker Avenue, Suite 8

Redwood City, CA 94063
Walnut Creek, CA 94598
Sacramento, CA 95834

(415) 364-9600
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FAX (916) 921-0100

Process Technologies, Inc.
P.O. Box 476
Boise, ID 83701
Attention: Mike Swan

Client Project ID: Site S - McClellan
Sample Descript: TCLP Extract of Solid, Two
Lab Number: 601-0118

Sampled: Jan 2, 1996
Received: Jan 4, 1996
Analyzed: Jan 11, 1996
Reported: Jan 19, 1996

TCLP VOLATILES

Analyte	EPA HW No.	Reporting Limit mg/L (ppm)	Regulatory Level mg/L (ppm)	Sample Results mg/L (ppm)
VOLATILES				
	R.L. Factor: 1			
Benzene.....	D018	0.020	0.5	N.D.
Carbon tetrachloride.....	D019	0.020	0.5	N.D.
Chlorobenzene.....	D021	0.020	100	N.D.
Chloroform.....	D022	0.020	6	N.D.
1,2-Dichloroethane.....	D028	0.020	0.5	N.D.
1,1-Dichloroethylene.....	D029	0.020	0.7	N.D.
Methyl ethyl ketone.....	D035	0.10	200	N.D.
Tetrachloroethylene.....	D039	0.020	0.7	N.D.
Trichloroethylene.....	D040	0.020	0.5	N.D.
Vinyl chloride.....	D043	0.020	0.2	N.D.

SEQUOIA ANALYTICAL
ELAP #1210

Janet Harlan
Janet Harlan

Project Manager/Sacramento Laboratory

Please Note:

Analytes reported as N.D. were not detected at or above the reporting limit. "R.L. Factor" greater than 1.0 indicates that matrix effects and/or other factors required additional sample dilution and a higher reporting limit.

6010118.PRO <1>

MEMORANDUM

CH2M HILL

TO: Rajeev Krishnan/CH2M HILL/CVO

FROM: Donna Morgans/CH2M HILL/CVO

DATE: February 28, 1996

SUBJECT: Review of Quality Assurance/Quality Control (QA/QC) Data from Offgas Samples Collected for the Silent Discharge Plasma Technology (SDPT) and Photolytic Discharge (PDT) at McClellan Offgas Force Base (AFB), Delivery Order 7036

PROJECT: 116462.36.M2

Summary

Overall, the data have met the acceptance criteria as outlined in the McClellan AFB Final Demonstration Work Plan Environmental Management of Offgas Technology and are usable for the purposes outlined in the context of the data quality objectives (DQOs). Nonconformances with project DQOs or QA/QC criteria are thoroughly discussed, identified, and qualified in this report.

The completeness objective is used as a measure of overall data quality for a certain data group. Completeness is defined as an evaluative measure that must be used with caution. Low completeness does not necessarily indicate poor laboratory performance. Matrix complications or unusual circumstances can affect the analyses, resulting in low completeness. The completeness objective was set at 95 percent for this project.

All total nonmethane organic compounds (TNMOC), and fixed gases (oxygen, carbon dioxide, and carbon monoxide) acetone and ozone analyses met all QA/QC criteria for the selected QC parameters.

The majority of volatile organic compound (VOC) analyses met all QA/QC criteria for the selected QC parameters. Deviations from the QA/QC criteria were observed as follows:

- Several VOCs were qualified as estimates and flagged with a "J" for positive results or an "NDJ" for the detection limit because continuing calibration criteria did not meet QC acceptance criteria.

The majority of semivolatile organic compound (SVOC) analyses met all QA/QC criteria for the selected QC parameters. Deviations from the QA/QC criteria were observed as follows:

- Several compounds were qualified as estimates and flagged with a "J" for positive results or a "UJ" for the detection limit because continuing calibration criteria did not meet QC acceptance criteria.
- Several compounds were qualified as estimates and flagged with a "J" for positive results or rejected and flagged with a "UR" for the detection limit because surrogate recoveries did not meet the laboratory specified control limits.

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116462.36.M2

- All offgas samples required dilution because the laboratory experienced difficulty when trying to concentrate the final extract to a volume of 1.0 mL. In all cases, a black tarry substance was formed during the concentration step and can be attributed to the formation of azeotrophs. As a result, two most highly concentrated SVOCs (naphthalene and 2-methyl naphthalene) were detected in the samples analyzed.

The majority of chloride/fluoride analyses met all QA/QC criteria for the selected QC parameters. Deviations from the QA/QC criteria were observed as follows:

- Three chloride results were qualified as biased low and flagged with an "L" for positive results or a "UL" for the detection limit because matrix spike recoveries did not meet the QC acceptance criteria.
- Two fluoride results were qualified as biased high and flagged with a "K" for positive results because matrix spike recoveries did not meet the QC acceptance criteria.

The majority of nitrate analyses met all QA/QC criteria for the selected QC parameters. Deviations from the QA/QC criteria were observed as follows:

- Twelve nitrate results were qualified as biased high and flagged with a "K" for positive results because matrix spikes recoveries did not meet the QC acceptance criteria.

Introduction

A review has been conducted on data collected for the SDPT and PDT Environmental Management of Offgas Technology Demonstration at McClellan AFB in Sacramento, California. This report summarizes the results of the QA/QC data associated with analyses of VOCs, SVOCs, TNMOC, acetone, fixed gases, chloride/fluoride, nitrate, and ozone.

All offgas samples were collected between November 9, 1995, and January 10, 1996. All samples were analyzed in accordance with and QA/QC criteria were taken from the following sources:

- U.S.EPA. Methods for Determination of Toxic Organic Compounds in Offgas, April 1984
- U.S.EPA. Standard Methods for the Analysis of Water and Wastes, 17th edition
- U.S.EPA. Test Methods for Evaluating Solid Wastes (SW 846), 3rd edition, September 1986
- National Institute of Occupation Safety and Health (NIOSH) 4th edition, August 1994
- U.S.EPA. Methods for Analysis of Water and Wastes, (EPA-600/4-84-017)
- ASTM Standards (D1947) Method for Analysis of Reformed Gas by Gas Chromatography (ASTM Vol. 05.05) 1990

MEMORANDUM

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- Oregon Department of Environmental Quality (ODEQ) Method 5

Two liquid condensate samples were collected and analyzed for VOCs (EPA Method 8240) and one liquid condensate sample was collected and analyzed for SVOCs (EPA Method 8270). No QC information was included with these analyses and will not be included in further discussions of data quality. Liquid condensate samples were analyzed by Sequoia Analytical laboratory located in Sacramento, California.

Table 1 lists the analytical methods performed and respective number of samples for each analysis.

Table 1 Summary of Analysis		
Parameter	Analytical Method	Number of Samples
VOCs by GC (screening)	EPA Modified Method 8010/8020	50 3 field duplicates
VOCs by GC/MS	EPA Method TO-14	27 3 field duplicates
SVOCs	EPA Method 8270	8 1 equipment blank
TNMOC	EPA Method TO-12	9
Fixed Gases	ASTM D1946	25 2 field duplicates
Acetone	NIOSH 1300	23 3 equipment blanks 3 field blanks 1 trip blank
Chloride/Fluoride	EPA Method 300.0	8 5 equipment blanks 4 field blanks 3 filter samples
Nitrate	EPA Method 300.0	23 1 equipment blank 4 field blanks
Ozone	NIOSH S8	15 1 equipment blank 2 field blanks
Particulate (Tare Weight)	ODEQ Method 5	6 filter samples

Offgas samples analyzed for VOCs, TNMOC, and fixed gas analyses were performed by Quanterra Environmental Services located in the City of Industry, California. All offgas

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samples analyzed for SVOCs were performed by Triangle Laboratories, Inc. located in Durham, North Carolina. All offgas samples analyzed for acetone, chloride/fluoride, nitrate, ozone and particulate were performed by the CH2M HILL Applied Science Laboratory located in Corvallis, Oregon.

Each laboratory provided analytical results and QA/QC information for all samples analyzed. Where possible, the data were reviewed in accordance with the 1994 version of the Environmental Protection Agency (EPA) *National Functional Guidelines for Organic or Inorganic Data Review*.

Data Usability Review

The intent of this review is to assess the appropriate use or "usability" of the analytical data for technology demonstration purposes based on the QA/QC data provided by the laboratory. The usability review focuses on criteria for the following QA/QC parameters and their overall effect on the data:

- Sample custody
- Holding times
- Initial and continuing calibrations
- Method blanks
- Sensitivity
- Surrogate spike recovery
- Matrix spikes
- Laboratory duplicates
- Laboratory control samples
- Field QA/QC

Sample Custody

All samples were properly recorded and transfer of custody was documented on each chain-of-custody (COC) form.

Holding Times

Holding time criteria monitor sample integrity that may be compromised over time. There are no EPA-approved holding times for the analysis of offgas samples. The following indicates the number of days that passed between the date of collection and the analysis date.

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Volatile Organic Compounds

All offgas samples analyzed by EPA Method TO-14 were performed between four and 13 days after the date of collection. All GC analyses were performed between one and six days after the date of collection.

Semivolatile Organic Compounds

All samples analyzed by EPA Method 8270 were extracted between five and 11 days after the date of collection.

Total Nonmethane Organic Compounds

All offgas samples analyzed by EPA Method TO-12 were analyzed between five and 11 days after the date of collection.

Acetone

All samples were analyzed between three and 12 days after the date of collection.

Fixed Gases

All samples were analyzed between two and 14 days after the date of collection.

Chloride/Fluoride

Offgas samples were analyzed between five and 13 days after the date of collection.

Nitrate

All offgas samples were analyzed between four and 18 days after the date of collection.

Ozone

All offgas samples were analyzed between four and 18 days after the date of collection.

Initial Calibration

Initial calibration criteria monitor analytical performance and proper compound identification at the start of analysis. All analyses met the QC acceptance criteria.

Continuing Calibration

Continuing calibration criteria monitor analytical performance and proper compound identification on a daily or more frequent basis.

MEMORANDUM

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February 28, 1996

116462.36.M2

Continuing calibration data were provided for each instrument used for analysis. A continuing calibration was performed using a mid-calibration range standard for each analytical batch. Except for several VOC and SVOC samples, continuing calibration criteria were met for all parameters.

Volatile Organic Compounds

The continuing calibration performed on November 17, 1995, @ 8:45 reported acetone (93%), benzyl chloride (63.3%), and hexachlorobutadiene (28.2%) outside the QC control limits of ± 25 percent difference. Samples COMOS-C04, COMOS-C04FD, PDT-C04, PDT-C04FD, SDPT-C04, and SDPT-C04FD were associated with this continuing calibration. All acetone, benzyl chloride, and hexachlorobutadiene results for these samples were qualified as estimates and flagged with a "J" for positive results or with an "NDJ" for the detection limit.

The continuing calibration performed on December 01, 1995, @ 11:26 reported freon-144 (30.8%), acetone (102.9%), chloroform (28.9%), benzyl chloride (71.1%), 1,2,4-trimethylbenzene (29.9%), and hexachlorobutadiene (34.5%) outside the QC control limits of ± 25 percent difference. Samples COMOS-C07, PDT-C06, and SDPT-C06 were associated with this continuing calibration. All freon-144, acetone, chloroform, benzyl chloride, 1,2,4-trimethylbenzene, and hexachlorobutadiene results for these samples were qualified as estimates and flagged with a "J" for positive results or with an "NDJ" for the detection limit.

The continuing calibration performed on December 13, 1995, @ 8:52 reported 2-hexanone (27.9%), styrene (28.4%), and 1,2,4-trichlorobenzene (29.3%) outside the QC control limits of ± 25 percent difference. Samples COMOS-C10 and PDT-C10 were associated with this continuing calibration. All dibromochloromethane, styrene, and 1,2,4-trichlorobenzene results for these samples were qualified as estimates and flagged with an "NDJ" for the detection limit.

The continuing calibration performed on December 18, 1995, @ 09:15 reported chloroethane (27%) and styrene (28.6%) outside the QC control limits of ± 25 percent difference. Samples COMOS-C12, PDT-C12, and SDPT-C10 were associated with this continuing calibration. All chloroethane and styrene results for these samples were qualified as estimates and flagged with an "NDJ" for the detection limit.

The continuing calibration performed on December 21, 1995, @ 09:15 reported freon-114 (29.9%), acetone (118.1%), cis-1,2-dichloroethene (29.8%), and benzyl chloride (54.5%) outside the QC control limits of ± 25 percent difference. Samples COMOS-C14, PDT-C14, and SDPT-C14 were associated with this continuing calibration. All freon-114, acetone, cis-1,2-dichloroethene, and benzyl chloride results for these samples were qualified as estimates and flagged with a "J" for positive results or with an "NDJ" for the detection limit.

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The continuing calibration performed on December 29, 1995, @ 09:03 reported acetone (106.1%), t-1,3-dichloropropene (26.5%), benzyl chloride (65.2%) and hexachlorobutadiene (28.3%) outside the QC control limits of ± 25 percent difference. Samples COMOS-C16, PDT-C16, and SDPT-C16 were associated with this continuing calibration. All acetone, t-1,3-dichloropropene, benzyl chloride and hexachlorobutadiene results for these samples were qualified as estimates and flagged with a "J" for positive results or with an "NDJ" for the detection limit.

The continuing calibration performed on January 03, 1996, @ 09:43 reported styrene (29.2%), benzyl chloride (36.2%), and 1,2,4-trichlorobenzene (46.9%) outside the QC control limits of ± 25 percent difference. Samples COMOS-C02 and SDPT-C18 were associated with this continuing calibration. All styrene, benzyl chloride, and 1,2,4-trichlorobenzene results for these samples were qualified as estimates and flagged with an "NDJ" for the detection limit.

The continuing calibration performed on January 15, 1996, @ 07:49 reported chloroethane (27.1%), 2-hexanone (35.9%), and styrene (29.4%) outside the QC control limits of ± 25 percent difference. Samples COMOS-C17, PDT-C17, SDPT-C19, SOMOS-C03, SOMOS-C04, and SDPT-C20 were associated with this continuing calibration. All chloroethane, 2-hexanone, and styrene results for these samples were qualified as estimates and flagged with an "NDJ" for the detection limit.

The continuing calibration performed on January 16, 1996, @ 09:36 reported freon-12 (27.6%), and styrene (31.2%) outside the QC control limits of ± 25 percent difference. Samples COMOS-C18 and PDT-C18 were associated with this continuing calibration. All freon-12 and styrene results for these samples were qualified as estimates and flagged with an "NDJ" for the detection limit.

Semivolatile Organic Compounds

The continuing calibration performed on December 08, 1995, @ 07:50 reported indeno(1,2,3-cd)pyrene (37.9%), dibenz(a,h)anthracene (36.8%), and benzo(g,h,i)perylene (46%) outside the QC control limits of ± 25 percent difference. Sample SDPTEBS01 was associated with this continuing calibration. All indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene results for this sample was qualified as an estimate and flagged with a "UJ" for the detection limit.

Method Blanks

Blank criteria monitor sample contamination through carry-over and instrument sensitivity.

Method blanks should be performed at a five percent frequency or once per analytical batch, whichever is more frequent. Blanks should be contamination-free to meet QC acceptance criteria. All method blanks met QC acceptance criteria.

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Sensitivity

Sensitivity criteria monitor achievement of method detection limits (MDLs) for each analytical method.

Table 2 shows the method detection limits (MDLs) achieved for each analysis.

Table 2 Method Detection Limits (MDL)	
Compound	MDL
VOCs (Method 8010/8210)	0.01 µg/L
VOCs (EPA Method TO-14)	2-10 µg/L
SVOCs (Method 8270)	0.2-0.5 µg
TNMOC (EPA Method TO-12)	0.05 mg/L
Fixed gases	0.01-0.1%
Acetone	0.5 ng/µL
Chloride/Fluoride	0.1 mg/L
Chloride/Fluoride (filter samples)	20 µg/L
Nitrate	20 µg/L
Ozone	1.0 µg

The following shows the parameters requiring dilution because of the high concentrations of target compounds. All sample results were properly adjusted by the dilution factor.

Offgas samples analyzed for VOCs by GC were reported with dilution factors between 0.17-fold and five-fold to bring high concentrations of VOCs into the linear range of the instrument.

Offgas samples analyzed for VOCs by EPA Method TO-14 were reported with dilution factors between 24-fold and 1,000-fold to bring high concentrations of VOCs into the linear range of the instrument.

Offgas samples analyzed for TNMOC by EPA Method TO-12 were reported with dilution factors between 39-fold and 1,700-fold to bring high concentrations of TNMOC into the linear range of the instrument.

Offgas samples analyzed for fixed gases were reported with dilution factors between 2.5-fold and 4.7-fold to bring high concentrations of fixed gases into the linear range of the instrument.

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All offgas samples analyzed for SVOCs required dilution to bring high concentrations of target and non-target compounds into the linear range of the instrument. All samples required dilution because the laboratory experienced difficulty when trying to concentrate the final extract to a volume of 1.0 mL. In all cases, a black tarry substance was formed during the concentration step and can be attributed to the formation of azeotrophs. As a result, two most highly concentrated SVOCs (naphthalene and 2-methyl naphthalene) were detected in the samples analyzed. The following indicates the dilution factor required for each sample analyzed: Samples PDT-3S and PDT-4S required a tenfold dilution; samples SDPT01SV01 and SDPT-2S-2I required 100-fold dilution; and sample SDPT02SV02, CIPDT-5S, and SDPT-1S-2I required 150-fold dilution.

Surrogate Spike Recovery

Surrogate spike recoveries monitor instrument-specific performance and accuracy. Surrogate spike recoveries were only reported with samples analyzed for semivolatile organic compounds.

Offgas samples analyzed for SVOCs were spiked with anthracene-d10, pyrene-d10, and terphenyl-d14 prior to analysis. Surrogate spike recoveries should fall within the laboratory specified control limits of 38 to 117 percent recovery for anthracene-d10, 34 to 126 percent recovery for pyrene-d10, and 19 to 136 percent recovery for terphenyl-d14 to meet QC acceptance criteria. Except for five samples, all surrogate spike recoveries met QC acceptance criteria.

Surrogate recoveries were not reported for samples SDPT-1S-2I and SDPT-2S-2I because surrogate compounds were diluted from the sample extract and could not be detected. These samples did not require qualification.

The surrogate recovery of anthracene-d10 was reported below the lower QC control limit for sample PDT-3S (17%) and the surrogate recovery of anthracene-d10 was reported above the upper QC control limit for sample CIPDT-1S (120%). The SVOC results for these samples were not qualified because only one surrogate recovery was outside the QC acceptance criteria.

The surrogate recovery of terphenyl-d14 was reported below the lower QC control limit for sample SDPT01SV01 (5%). Surrogate recoveries for anthracene-d10 and pyrene-d10 were not reported for this sample because surrogate compounds were diluted from the sample extract and could not be detected. All SVOC results for the sample were qualified as estimates and flagged with "J" for positive results or rejected and flagged with a "UR" for nondetected results.

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Precision and Accuracy

Precision criteria monitor analytical reproducibility and accuracy criteria monitor agreement with "true values" as determined by analytical spike recovery.

Matrix Spike/Matrix Spike Duplicates

Matrix spikes and matrix spike duplicates (MS/MSDs) should be analyzed at a frequency of 5 percent or once per analytical batch to meet frequency QC acceptance criteria. MS/MSDs were not reported with the analysis of VOCs, TNMOC, fixed gases, and ozone. MS/MSD recoveries should be within the control limits of 80 to 120 percent and ± 30 relative percent difference (RPDs) for acetone and ± 20 RPD for all other parameters to meet QC acceptance criteria.

Acetone

Four (CIPDT-I3-03, PDT-I3-02, PDT-I3-04, and PDT-3T02-04) MS/MSDs (10 percent frequency) were analyzed for acetone analysis, therefore meeting frequency QC acceptance criteria. All MS/MSD recoveries and RPD results met the QC acceptance criteria.

Chloride/Fluoride

Three offgas (SDPT-EBS-01H, PDT-3S-EBS, and SDPT-1H-2I) (17.6 percent frequency) MS/MSDs and one filter (PDT-1H-FFR) (30 percent frequency) MS/MSD were analyzed, therefore meeting frequency QC acceptance criteria. Except for one chloride and one fluoride MS/MSD recovery, all MS/MSD recoveries and RPD results met QC acceptance criteria.

The matrix spike (78.1%) and matrix spike duplicate (71.6%) recoveries associated with sample SDPT-1H-2I were slightly below the lower QC control limits for chloride. Chloride sample results associated with samples SDPT-1H (773 L), SDPT-2H-2I (889 L), and SDPT-1H-F2I (0.10 UL) were qualified as biased low and flagged with an "L" for positive results or a "UL" for the detection limit.

The matrix spike (124%) and matrix spike duplicate (123%) recoveries associated with sample SDPT-EBS-01H were slightly above the upper QC control limits for fluoride. Fluoride sample results associated with samples PDT-1H-I (1.29 K) and PDT-2H-02I (1.80 K) were qualified as biased high and flagged with a "K" for positive results.

Nitrate

Three (SEC-1N, PDT-EBN-2I, and PDT-1N3-2I) (10.7 percent frequency) MS/MSDs were analyzed for nitrate analysis, therefore meeting QC frequency acceptance criteria. Except for one MS/MSD, all MS/MSD recoveries and RPD results met QC acceptance criteria. The

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matrix spike (127%) and matrix spike duplicate (128%) recoveries associated with sample SEC-1N were slightly above the upper QC control limits for nitrate. Nitrate sample results for the following samples were qualified as biased high and flagged with a "K" for positive results:

PDT-FBN-1B (43.2 K), PDT-FBN-1A (47.1 K), PDT-FBN-1 (54.8K), PDT-1N (54.1 K), PDT-2N (78.3 K), SDPT-1N1-3I (2071 K), SDPT-1N1-3I DIL (1,787 K), SDPT-1N2-3I (94.5 K), SDPT-1N3-3I (93.3 K), SDPT-1NF-3I (66.4 K), SDPT-2N1-3I (641 K), and SDPT-2N2-3I (78.5 K)

Ozone

Two (PDT-2R-1ZIMS and SDPT-321I2)(13.3 percent frequency) MS/MSDs were analyzed for ozone analysis, therefore meeting frequency QC acceptance criteria. All recoveries and RPD results met QC acceptance criteria.

Laboratory Duplicates

Laboratory duplicates should be analyzed at a frequency of five percent or once per analytical batch, whichever is more frequent. RPD results should fall within the QC control limits of ± 30 percent to meet QC acceptance criteria.

VOCs

Thirteen (24.5 percent frequency) laboratory duplicates were analyzed for VOCs by GC, therefore meeting frequency QC acceptance criteria. All RPD results met QC acceptance criteria.

Acetone

Three (CISDPT-I3-02, PDT-EBS-02, and PDT-3T02-04) (10 percent frequency) laboratory duplicates were analyzed, therefore meeting frequency QC acceptance criteria. Except for one laboratory duplicate, all laboratory duplicate RPD results met QC acceptance criteria for laboratory precision. The RPD result (53.3%) for laboratory duplicate CISDPT-I3-02 did not meet QC acceptance criteria. No samples associated with this laboratory duplicate required qualification.

Laboratory Control Samples

Laboratory control samples (LCS) should be analyzed with each analytical batch to meet frequency acceptance criteria. LCS recoveries should be within the control limits of 80 to 120 percent to meet QC acceptance criteria.

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A LCS was analyzed with each analytical batch, therefore meeting frequency QC acceptance criteria. All recoveries met QC acceptance criteria.

Field QA/QC

Equipment Blanks

Equipment blanks are primarily used to indicate if contamination has occurred as a result of sample collection or handling procedures.

One equipment blank was collected with SVOC samples; six equipment blanks were collected with acetone samples; nine equipment blanks were collected with chloride/fluoride samples; five equipment blanks were collected with nitrate samples; and three equipment blanks were collected with ozone samples. Except for one VOC, one acetone, and five nitrate equipment blanks, all equipment blanks were contamination-free. No samples required qualifications as a result of equipment blank contamination.

Trip Blanks

Trip blanks are used primarily to indicate possible contamination that may occur during packaging, shipping, and handling.

One trip blank (PDT-TB) was collected on 12/06/95 and submitted with samples analyzed for acetone. Acetone (2.9 mg) was detected in the trip blank. No acetone results were qualified because of the trip blank contamination.

Field Duplicates

Field duplicates are another measure of reproducibility by duplicate analysis.

Field duplicate results are used to determine the precision of field sampling and laboratory techniques. There are no criteria or control limits for RPD of field duplicates; therefore laboratory duplicate criteria were applied. This allows control limits of ± 30 RPD with the provisional control limit of plus or minus the MDL when sample concentrations are less than five times the MDL. These control limits may be too stringent, since precision in this case involves both sampling and laboratory precision. There are no specific review criteria used to compare field sample result comparability. Qualifiers are not assigned when field duplicate results do not meet QC acceptance criteria.

Three offgas samples were collected in duplicate (COMOS-C04/COMOS-C04FD, PDT-C04/PDT-C04FD, and SDPT-C04/SDPT-C04-FD) (10 percent frequency) and analyzed for VOCs by EPA TO-14. Two offgas samples were collected in duplicate (PDT-C04/PDT-C04FD and SDPT-C04/SDPT-C04-FD) (7.4 percent frequency) and analyzed for fixed gases. Three offgas samples were collected in duplicate (COMOS-C03/COMOS-C03FD,

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PDT-C03/PDT-C03FD, and SDPT-C03/SDPT-C03-FD) (5.7 percent frequency) and were analyzed for VOCs by GC method.

Table 3 shows field duplicate RPD results for VOCs (EPA Method TO-14) and fixed gas results that were detected in one or both of the samples analyzed.

Table 3 Field Duplicate Results for EPA Method TO-14 and Fixed Gases			
Compounds	Sample Result (ppbv)	Duplicate Result (ppbv)	Relative Percent Difference
COMOS-C04/COMOS-C04 FD			
1,1-Dichloroethene	3,960	4010	1.3
Acetone	60,100	59,800	0.5
Methylene Chloride	6,080	6980	13.8
1,1-Dichloroethane	3,690	3650	1.1
cis-1,2-Dichloroethene	2,270	2440	7.2
2-Butanone	7270	6650	8.9
1,1,1-Trichloroethane	1,78,000	1,87,000	4.9
Trichloroethene	80,500	83,300	3.4
4-Methyl-2-pentanone	19,600	19,700	0.5
Toluene	46,000	46,600	1.3
1,1,2-Trichloroethane	810	2.0 U	N/C
Tetrachloroethene	54,600	56,500	3.4
Ethylbenzene	2,350	2,270	3.5
Xylene (total)	11,300	11,400	0.9
4-Ethyl toluene	3,500	3,420	2.3
1,3,5-Trimethylbenzene	2,240	2,240	0.0
1,2,4-Trimethylbenzene	5,320	5,310	0.2
1,4-Dichlorobenzene	1,580	1,640	3.7
1,2-Dichlorobenzene	9,100	8,660	4.9
PDT-C04/PDT-C04 FD			
Acetone	33,600	36,400	8.0
Methylene Chloride	3,030	3,040	0.3
1,1-Dichloroethane	1,160	1,180	1.7
Chloroform	1,950	2,030	4.0
1,1,1-Trichloroethane	83,500	95,400	13.3
Tetrachloroethene	532	2.0 U	N/C
Carbon dioxide (%(v/v))	0.45	0.45	0.0
Oxygen (%(v/v))	19.3	19.1	1.0
Carbon monoxide (%(v/v))	0.05	0.053	6.0
SDPT-C04/SDPT-C04 FD			
Acetone	17,500	14,400	19.4
Methylene Chloride	1,750	2,400	31.3
1,1-Dichloroethane	504	2.0 U	N/C

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Table 3
Field Duplicate Results for EPA Method TO-14 and Fixed Gases

Compounds	Sample Result (ppbv)	Duplicate Result (ppbv)	Relative Percent Difference
cis-1,2-Dichloroethene	2.0 U	22700	N/C
1,1,1-Trichloroethane	53,600	47,600	11.9
Trichloroethene	2.0 U	25,200	N/C
Toluene	2.0 U	638	N/C
Tetrachloroethene	897	16,700	180
Carbon dioxide (%(v/v))	2.53	2.61	3.1
Oxygen (%(v/v))	17.8	17.7	0.6
Carbon monoxide (%(v/v))	0.156	0.163	4.4
U = Not detected at or below the MDL N/C = Not calculable			

Nineteen VOCs were detected in the offgas samples collected at location COMOS-C04. All RPDs met the QC acceptance criteria for field precision. 1,1,2-Trichloroethene was not detected in the duplicate sample, therefore an RPD could not be calculated.

Six VOCs and fixed gases were detected in the offgas samples collected at location PDT-C04. All RPDs met the QC acceptance criteria for field precision. Tetrachloroethene was detected in the parent sample only, therefore an RPD could not be calculated.

Eight VOCs and fixed gases were detected in the offgas samples collected at location SDPT-C04. Except for methylene chloride and tetrachloroethene, all RPDs met the QC acceptance criteria for field precision. The RPD results for methylene chloride (31.3 percent) and tetrachloroethene (180 percent) were outside the QC acceptance criteria for field precision. cis-1,2-Dichloroethene, trichloroethene, and toluene were detected in the parent sample only and 1,2-dichloroethane was detected in the duplicate sample only, therefore RPDs could not be calculated for these compounds.

Table 4 shows field duplicate RPD results for VOCs by GC method that were detected in one or both of the samples analyzed.

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Table 4 Field Duplicate Results for VOCs by Method 8010/8020			
Compounds	Sample Result (ppmv)	Duplicate Result (ppmv)	Relative Percent Difference
COMOS-C03/COMOS-C03FD			
Trichloroethene	93.4	96.8	3.6
Tetrachloroethene	68.1	71.6	5.0
1,1,1-Trichloroethane	210.1	218.7	4.0
cis-1,2-Dichloroethene	2.6	4.0	7.4
1,1-Dichloroethane	3.9	6.9	2.5
Methylene chloride	6.8	6.9	1.5
1,1-Dichloroethene	5.0 U	3.1	N/C
1,2-Dichlorobenzene	7.6	8.7	13.5
1,2,4-Trichlorobenzene	8.1	8.7	7.1
o-Xylene	2.9	3.0	3.4
m,p-Xylene	9.2	9.6	4.3
Ethyl benzene	2.5	3.9	43.8
Toluene	46.5	47.1	1.3
PDT-C04/PDT-C04 FD			
Tetrachloroethene	1.3	2.0	42.4
1,1,1-Trichloroethane	100.3	97.6	2.4
Methylene Chloride	2.3	2.3	0
SDPT-C03/SDPT-C03 FD			
Tetrachloroethene	1.3	1.2	8.0
1,1,1-Trichloroethane	53.32	52.6	1.3
Methylene Chloride	1.6	1.5	6.5
U = Not detected at or below the MDL N/C = Not calculable			

Thirteen VOCs were detected in the offgas samples collected at location COMOS-C03. All RPDs met the QC acceptance criteria for field precision. 1,1-Dichloroethane was detected in the duplicate sample only, therefore an RPD could not be calculated.

Three VOCs were detected in the offgas samples collected at location PDT-C03. All RPDs met the QC acceptance criteria for field precision.

Three VOCs were detected in the offgas samples collected at location SDPT-C03. All RPDs met the QC acceptance criteria for field precision.

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Completeness

Completeness criteria monitor the percentage of measurements judged to be valid compared to the expected total amount of measurements. The overall completeness objective for acceptable analytical data for this treatability study was set at 95 percent.

The completeness objective of 95 percent based on precision and accuracy was met for all analyses.

Data Review of Dioxin Samples Collected for the Silent Discharge Plasma Technology and the Photolytic Discharge Technology Demonstration at McClellan Air Force Base

TO: Rajeev Krishnan/CVO
FROM: Donna Morgans/CVO
DATE: January 23, 1996

Introduction

This report summarizes the results of a data review of analytical data generated from seven air samples collected on M23 sampling trains. Components of the M23 sampling train (XAD and water) were combined, extracted, and analyzed. The purpose of this review was to determine the "usability" of the data based on quality control requirements from the EPA's *Method 1613: Tetra- through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS, Revision A, April 1990*.

The M23 sampling trains were collected between December 5, 1995, and December 7, 1995, and analyzed for tetra- through octa-chlorinated dioxins and furans. The analysis was performed by Triangle Laboratories, Inc. located in Durham, North Carolina.

The QA/QC data were reviewed in terms of blanks and laboratory accuracy and precision. The review of blanks included method blanks and field blanks. Accuracy was measured by percent recoveries of compounds from continuing calibrations, laboratory blank spikes, and internal standard spikes. Laboratory precision is normally measured by relative percent difference (RPD) between duplicate analyses of blank spikes for matrix spikes. However, due to the small number of samples collected, duplicate analyses were not performed; therefore, laboratory precision could not be evaluated.

Blanks

Blanks provide information that is used to monitor potential contamination. The blanks in this review include method blanks and field blanks. All blanks undergo the same analytical process.

Field Blank (FB) - Field blanks were collected to monitor potential contamination caused by incomplete equipment decontamination. One field blank was collected from each sample collection point.

Method Blank (MB) - Method blanks are used to monitor laboratory performance and contamination introduced during the analytical procedure. One method blank was analyzed per analytical batch, therefore meeting frequency QC acceptance criteria.

Field blanks PDT-1D-FB and SDPT-1D-FB are associated with samples collected between December 5 and December 7, 1995. Target analytes were detected in both field blanks. Field blank PDT-1D-FB is associated with sample PDT-1D and sample PDT-2D. Field blank SDPT-1D-FB is associated with sample SDPT-1D and sample SDPT-2D. If the target analyte result in the field sample is less than five times the analyte result detected in the associated field blank, that target analyte result is considered an artifact of contamination and is flagged as a nondetect. In the case of field samples collected between December 5 and December 7, 1995, most target analytes detected in the field samples were less than five times the result detected in the associated field blank. Therefore, those field sample results were considered an artifact of contamination and were flagged as nondetects.

Accuracy

Accuracy is a measure of how close the measurement is to the true value. Accuracy can be assessed in terms of laboratory performance and matrix interference. Laboratory performance is assessed by extraction efficiency, cleanup efficiency, and instrument performance. Matrix interference is normally assessed by matrix spikes. However, due to the small number of samples collected, matrix spikes were not performed; therefore, matrix interference could not be evaluated.

Internal standard spike recoveries are used to assess both extraction efficiency and instrument performance. Internal standard compounds are spiked into the sample prior to extraction to monitor extraction efficiency. Internal standard area counts are used in the quantitation of target analyte results to compensate for normal fluctuations in instrument response. Acceptance limits for all internal standards are between 25 percent and 150 percent. Except for sample SDPT-2D, all internal standard spike recoveries ranged between 57 percent and 110 percent. The recovery standard $^{13}\text{C}_{12}$ -1,2,3,7,8,9-HxCDD for sample SDPT-2D was affected by matrix interference. Because this recovery standard is used to quantitate the hexa, hepta, and octa labeled internal standards, all hexa, hepta, and octa labeled internal standards have artificially elevated recoveries with some recoveries above the upper acceptance limit of 150 percent. The internal standard area counts were not affected by the interference; therefore, analyte results were not affected.

Several internal standards were spiked into the samples prior to sample collection. Those internal standards include $^{13}\text{C}_{12}$ -23478-PeCDF, $^{13}\text{C}_{12}$ -123478-HxCDF, $^{13}\text{C}_{12}$ -1,2,3,7,8,9-HxCDF, and $^{13}\text{C}_{12}$ -1,2,3,4,7,8,9-HpCDF. Spiking internal standards prior to sample collection is not specified in Method 1613; however, the quality of the data should not be affected.

Clean-up efficiency is normally monitored by percent recovery of $^{37}\text{C}_{14}$ -2,3,7,8-TCDD, which is spiked into the sample after extraction and prior to clean-up. The surrogate was spiked into the XAD trap prior to sample collection. Therefore, the surrogate recovery for $^{37}\text{C}_{14}$ -2,3,7,8-TCDD actually represents sample collection efficiency of the XAD trap. Spike recoveries ranged from 53 percent to 73 percent for all samples. Method 1613 does not specify the use of surrogate recoveries for collection efficiency, thus acceptance limits are not available.

Instrument performance was assessed in terms of continuing calibrations and blank spikes. One continuing calibration was analyzed on December 29, 1995. Continuing calibrations are assessed by percent recoveries, mass to charge (m/z) abundance ratios, and signal to noise (S/N) ratios of the spiked compounds. All parameters were within method control limits.

One blank spike was analyzed on December 29, 1995. Blank spike recoveries showed good accuracy with percent recoveries between 92 percent and 109 percent for all compounds.

Conclusion

The laboratory quality control associated with the samples collected showed good accuracy. Continuing calibration, blank spike, and internal standards showed good accuracy for all samples. Internal standard spike recoveries for hexa, hepta, and octa labeled internal standards were elevated due to matrix interference in recovery standard $^{13}\text{C}_{12}$ -1,2,3,7,8,9-HxCDD. However, the internal standard area counts were not affected by the interference; therefore, analyte results should not be affected.

Matrix spikes and laboratory duplicates were not analyzed for this data set due to the small number of samples collected; therefore, matrix interference and laboratory precision were not evaluated.

Although matrix interference and precision could not be evaluated in this sample set, the available quality control information indicates that the data generated by Triangle Laboratories, Inc. are usable for the purposes outlined in the Demonstration Work Plan.

APPENDIX K

Cost Backup Information

Assumptions and Basis for Catox/Scrubber Capital Costs Used in Table 5, Page 20

Table K-1 summarizes two vendor quotes for comparable Catox/Scrubber systems. The average of these two estimates is used in Appendix J as a baseline comparison to the PDT cost estimate. Due to the established nature of the Catox technology the following estimates provide a greater degree of accuracy than does the PDT estimate. Note also that the average vendor scrubber cost is also used in the PDT cost estimate.

TABLE K-1
Catox/Scrubber Capital Cost Estimate Summary

Estimate Title	Type	System Capacity (cfm)	Catox	Scrubber	Total Capital Cost
Met Pro	Vendor quote	250	\$65,000	\$44,000	\$109,000
Wheelabrator	Vendor quote	400*	\$149,000	\$129,000	\$278,000
Average (of vendor quotes)			\$107,000	\$86,500	\$193,500

* The 400 cfm unit is the smallest in the Wheelabrator line and will treat a 250 cfm stream.

For comparison purposes, the engineers' cost estimate for a 250-cfm system was \$238,000 (Catox \$70,000, scrubber \$168,000). This is well within the budgetary accuracy limits of the vendor quotes shown in Table K-1.

The remainder of Appendix K contains calculations and vendor quotes to provide back-up for Table K-1 estimates.

Assumptions and Basis for Costs Used for Comparison in Table K-1 (Engineer's Estimate)

1. Installed capital cost of Catox for the 1,200 cfm system installed at Site S, OU D = \$180,000 (Hodge and Danko, 1994).
2. Scaled down cost for a 250 cfm unit is estimated from the "6/10" rule (Perry and Chilton, 1973).

$$\frac{C_1}{C_2} = \left(\frac{r_1}{r_2} \right)^{0.6}$$

where C_1 = cost of equipment 1

r_1 = capacity of equipment 1

C_2 = cost of equipment 2

r_2 = capacity of equipment 2

∴ Cost of 250 cfm unit =

$$\begin{aligned} C_1 &= \$180,00 \times \left(\frac{250}{1,200} \right)^{0.6} \\ &= \$70,000 \end{aligned}$$

3. Similarly installed capital cost for the 250 cfm scrubber was estimated to be = \$168,000

4. \$70,000 + \$168,000 = \$238,000

Assumptions and Basis for Costs Used in Table 5, Page 20

1. The estimated installed capital cost for the Catox/scrubber system is \$193,500. This cost is an average of two vendor quotes. Catox/scrubber capital cost calculations are located in Appendix K.

2. Actual yearly maintenance for the Catox system at OU D = \$12,400

Actual yearly maintenance for the scrubber and auxiliary equipment at OU D = \$92,700

Actual yearly maintenance for the wellfield and blower at OU D = \$18,500

Total maintenance and supervision labor at \$60 per hour =

$$\frac{\$60}{\text{hr}} \times \frac{70 \text{ hr}}{\text{mo}} \times \frac{12 \text{ mo}}{\text{yr}} = \$50,400$$

Total maintenance and supervision labor for the Catox/scrubber system at OU D = \$174,400 per year or \$14,500 per month.

For consistency, the costs associated with the scrubber and well and blower maintenance are not included in the summary table presented in the text, or in the cost breakdown table.

3. Catalyst replenishment for 1,200 cfm unit
(Hodge & Danko, 1994)

$$= \$33,600/\text{yr}$$

$$\text{Therefore, for a 250 cfm unit} = \$33,600 \times \frac{250}{1,200}$$

$$= \$7,000/\text{yr}$$

$$= \$580/\text{month}$$

4. Similarly, natural gas for Catox for a 250 cfm unit
(Hodge & Danko, 1994)

$$= \$13,000/\text{yr}$$

$$@ \approx \$3/\text{million BTU} = \$1,080/\text{month}$$

5. Similarly, electricity (@ \$0.10/kWh) for a 250-cfm unit

$$= \$250/\text{month}$$

6. Similarly, expendables (caustic @ \$0.40/lb) for scrubber

$$= \$2,080/\text{month}$$

7. NOx loading is calculated from an average of 5 data points collected at the Site S Catox between March 1995 and March 1996. The estimated yearly NOx emission of 205 pounds equates to approximately \$4,000 of annual fees. Annual fees are based on information supplied by Tim Chapman/BDM; calculations are shown on pages K-6 and K-7.

*Note that the Catox and scrubber system are not very sensitive to the concentration of the SVE offgas. Therefore, most of the above operating costs are proportional to flow rate and were interpolated from operating and maintenance costs for a 1200 cfm unit (Hodge and Danko, 1994). A cursory cost comparison between the above calculations

and the vendor estimates indicated that the costs determined here are conservatively high.

Assumptions and Basis for Costs Used in Table 6, Page 20

Table K-2 provides the basis for costs estimated for a 240 cfm PDT system in Table 6 of this report. Many of the costs are based on scale-up costs from the 12 cfm pilot system used during the demonstration and on information supplied by PTI.

Table K-2

PTI Cost Summary

Capital Costs

Reactor size	24 ¹	240 ⁹ cfm
Reactor cost	\$54,200	\$542,000
Scrubber (not used during demonstration)	\$10,000	\$86,500 ¹⁰
Controls	\$4,000	\$14,000
Installation	\$800 ²	\$8,000 ¹¹
Total capital costs	\$69,000	\$650,500

Yearly Operations and Maintenance Costs

Power

Total Calculated Load =	44 ³	412 ¹² kW
Total run time =	7,446 ⁴	7,446 ¹³ Hrs/Yr
Energy cost =	\$0.07	\$0.07 per kWh

Total electricity cost = \$25,000 \$233,000 per year

Consumables

Liner replacement =	\$18,000 ⁵	\$180,000 ¹⁴ per year
Liner disposal =	\$405 ⁶	\$4,050 ¹⁵ per year
Lamp replacement =	\$13,800 ⁷	\$138,000 ¹⁶ per year

Labor

Operating labor =	\$16,400 ⁸	\$82,000 ¹⁷ per year
Total operating cost =	\$73,605	\$637,050 per year

¹ Costs are based on those incurred during demonstration

² Installation cost assumes 16 technician hours @ \$50.00/hour

³ Total load calculated from power ratings of all connected equipment (based on PTI estimate for a 24 cfm reactor, see page K-6)

⁴ Total run time is based on 7,446 hours per year (85% uptime)

⁵ 100 panels, 18 changes/year @ \$10.00/panel (based on PTI estimate)

⁶ 15 lbs/panel @ \$30.00/ton landfill disposal cost (assumes liner is nonhazardous)

⁷ 600 lamps/year @ \$23.00/lamp (based on manufacturers expected service life)

⁸ 16 hours/panel changeout + 40 hours/lamp changeout @ \$50/hour (includes supervisory time) based on experience during the demonstration

⁹ Based on ten 24 cfm reactors

¹⁰ Average of two vendor estimates, see Table K-1

¹¹ Installation cost for the 240 cfm system assumes 160 technician hours @ \$50.00/hour (2 technicians, 1 day per reactor)

¹² Total load calculated from power ratings of all connected equipment (based on PTI estimate for a 240 cfm reactor, see page K-6)

¹³ Total run time based on 7,446 hours per year (85% uptime)

¹⁴ 100 panels in each of 10 reactors, 18 changes/year @ \$10.00/panel (based on PTI estimate)

¹⁵ 15 lbs/panel @ \$30.00/ton landfill disposal cost (assumes liner is nonhazardous)

¹⁶ 600 lamps/year per 24 cfm reactor (10 reactors) @ \$23.00/lamp (based on manufacturers expected service life)

¹⁷ Similar to 24 cfm reactor calculation X10 (plus X 0.5 for increased operator efficiency on larger system)

PTI Power Consumption

The following calculations describe assumed power usage for a 24 cfm PDT system.

Lamps	300 ballasts X 1.24 amps = 372 @ 120 volt nominal amps
Equipment	Cooling water pump = 11.28 amps @ 115 volt, 1 ϕ Blowdown pump = 12 amps @ 115 volt, 1 ϕ Purge blower = 1.44 amps @ 208 volt, 3 ϕ
Total	395.28 amps @ 1 ϕ /3 = 131.76 amps @ 208 volt +1.44 amps = 133.2 @208 volt
Power	208 volts X 133.2 amps X $\sqrt{3}$ X .91/1000 power factor = 43.67 kW

The following calculations describe assumed power usage for a 240 cfm PDT system.

Lamps	300 ballasts X 1.24 amps X 10 = 3720 @ 120 volt nominal amps
Equipment	2 Cooling water pumps = 22.56 amps @ 115 volt, 1 ϕ 2 Blowdown pumps = 24 amps @ 115 volt, 1 ϕ 1 Purge blower = 1.44 amps @ 208 volt, 3 ϕ
Total	3766.56 amps @ 1 ϕ /3 = 1255.52 amps @ 208 volt +1.44 amps = 1256.96 @208 volt
Power	208 volts X 1256.96 amps X $\sqrt{3}$ X .91/1000 power factor = 412 kW

Power consumption data provided by PTI

Emission Rates Based on NOx Measurements Compiled by CH2M HILL

At Site S OU D McClellan AFB between 3/95 and 3/96.

Date	lbs/hr	lbs/yr (avg 1,200 cfm flow)
March 1995	0.09	790
April 1995	0.17	1490
August 1995	0.11	964
November 1995	0.074	650
March 1996	0.118	1034
Estimated Yearly Average (at 100% uptime)		986 lbs/yr

Basis:

Cost per credit \approx \$30,000/ton

Percent uptime \approx 85%

$$\text{Flow rate correction} \quad 986 \cdot \frac{250}{1,200} = 205 \frac{\text{lbs}}{\text{yr}}$$

$$\text{Percent uptime correction} = \quad 205 \times 0.85 = 174.25 \frac{\text{lbs}}{\text{yr}}$$

$$\text{Number of credits needed (quarterly)} = \quad \frac{1}{4} \quad \frac{174.25 \times 1.3^*}{2,000 \text{ lbs / ton}} = 0.0283$$

$$\text{Quarterly cost} = \quad 0.0283 \times 30,000 = \$850$$

$$\text{Yearly cost} = \quad 850 \times 4 = \$3,400$$

*Cost per credit, and 1.3 emission resolution credit (ERC) factor, is based on information supplied by Tim Chapman/BDM.



Systems Division

160 CASSELL RD. • BOX 144 • HARLEYSVILLE, PA 19438 USA • (215) 723-6751 • FAX: (215) 723-6161

MET-PRO QUOTATION SUMMARY FOR CH2M HILL

	CATALYTIC OXIDATION / QUENCH / SCRUBBER SYSTEM
Flowrate (SCFM)	250
Solvent Destruction Efficiency (Percent)	99%
HCl Removal Efficiency (Percent)	99%
Natural Gas Usage (BTU/HR)	190,000
Equipment Cost (US Dollars)	\$109,000.00
Delivery (Weeks)	14

DATE: April 29, 1996

NAME: Thomas Farvesse

SIGNATURE: _____

PHONE: (215) 723-6751 X 232

FAX: (215) 723-6161

NATURAL GAS COST $190,000 \frac{\text{BTU}}{\text{hr}} \cdot \frac{\text{therm}}{100,000 \text{ BTU}} \cdot \frac{\$0.233}{\text{therm}} \cdot \frac{24 \text{ hr}}{\text{day}} \cdot \frac{30 \text{ day}}{\text{month}} = \$320/\text{month}$

CH₂M HILL TELEPHONE CONVERSATION RECORD

CALL TO TOM PARVESSE / METPRO SYSTEMS
DIVISION

PHONE NO. (215) 723-6751

SUMMARY OF CONVERSATIONS

DATE FROM 4/22 → 5/2/1996

CALL FROM CHAD DUTTON / AL DAVIS

TIME _____ ☐ AM ☐ PM

MESSAGE TAKEN BY _____

PROJECT NO. _____

SUBJECT CATOX / SCRUBBER PRICE QUOTE

- TOM EXPECTS A NATURAL GAS USAGE OF 150,000 BTU/hr
- " " AN ELECTRICITY USAGE OF 2KW/hr
- THE INITIAL CHARGE OF CATALYST IS EXPECTED TO LAST 3 TO 5 YEARS (CH₂M HILL ASSUMES THE "INITIAL CHARGE" INCLUDES A RESERVE TO BE ADDED DURING SERVICE)

- TOM EXPECTS 99 TO 100% UPTIME FOR THE SYSTEM
- LABOR FOR THE SYSTEM IS MINIMAL, IT CAN BE OPERATED REMOTELY.



Wheelabrator Clean Air Systems Inc.

A Wheelabrator Technologies Company
1501 E. Woodfield Road, Suite 200 West
Schaumburg, IL 60173-5417

Phone 847.706.6900

April 25, 1996

Mr. Chad Dutton
CH2M HILL INC
2300 NW Walnut
Corvallis, OR 97330

REFERENCE: USAF Soil Remediation, Central California

Dear Chad:

We have reviewed the data you faxed to us the other day and can offer the following information for this application:

- The base price for our smallest skid mounted system, Model VC400 catalytic oxidizer, for chlorinated hydrocarbons is \$120,000.
- A budgetary price for a wet HCl scrubber with a chemical feed package is \$100,000.
- Control panel (plc based) cost is approximately \$30,000.
- Shipping to central CA will cost about \$8,000.
- Installation start-up and training will be an additional \$20,000.
- Delivery is around 22 weeks.

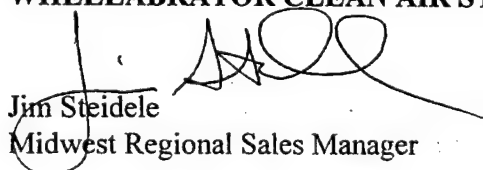
Operating costs for gas and electricity will be around \$1.00 per hour. Labor is estimated at 0.5 hours per shift. ^{8 hour shift}

$$30 \cdot 1.5 \cdot \$50 = \$2250/\text{MONTH} \quad 30 \cdot 24 \cdot \$1.00 = \$720/\text{MONTH}$$

Should you have any questions or comments, please feel free to contact us at (847) 706-6900, or me directly at (847) 706-6976.

Very truly yours,

WHEELABRATOR CLEAN AIR SYSTEMS INC.


Jim Steidele
Midwest Regional Sales Manager

JES/jmn

cc: Mr. John Enright/Enright Associates Bothell, WA

CHM HILL TELEPHONE CONVERSATION RECORD

CALL TO JIM STEIDEL / WHEELABRATOR CLEAN AIR
SYSTEMS, INC.

PHONE NO. (847) 706-6900

DATE SUMMARY OF CONVERSATIONS
FROM 4-22 → 5-1-1996

CALL FROM CHAD DUTTON / AL DAVIS

TIME ☐ AM ☐ PM

MESSAGE TAKEN BY

PROJECT NO.

SUBJECT CATOX / SCRUBBER PRICE QUOTE

JIM STATED THAT THE SYSTEM ON WHICH HE QUOTED WAS
 CAPABLE OF TREATING 400 SCFM (THE VC400 IS WHEELBRADERS
 SMALLEST UNIT)

THE LABOR ESTIMATE IS BASED ON 3 SHIFTS DURING A
 24 HOUR PERIOD. HOWEVER, HE WENT ON TO SAY THAT
 UNDER NORMAL OPERATION THE SYSTEM CAN OPERATE FOR WEEKS
 AT A TIME UNATTENDED.

JIM EXPECTS THE WHEELABRATOR SYSTEM TO PROVIDE 99%
 UPTIME.

JIM EXPECTS THE CATALYST PROVIDED IN THE ORIGINAL DELIVERY
 OF EQUIPMENT TO PROVIDE SERVICE FOR 2 YEARS.

CATOX AND SCRUBBER COSTS WERE SEPARATED OUT AS FOLLOWS:

$$\text{CATOX: } \$120,000 \cdot \frac{\text{CONTROLS } 30,000}{2} \cdot \frac{\text{SHIPPING } 8,000}{2} \cdot \frac{\text{INSTALLATION } 20,000}{2} = \$149,000$$

$$\text{SCRUBBER: } \$100,000 \cdot \frac{30K}{2} \cdot \frac{8K}{2} \cdot \frac{20K}{2} = \$114,000$$

CH2M HILL TELEPHONE CONVERSATION RECORD

CALL TO JIM STEIDELE / WHEELABRATOR

PHONE NO. (847) 706-6900

DATE 6-24-96

CALL FROM AL DAVIS

TIME _____ ☒ AM ☐ PM

MESSAGE TAKEN BY _____

PROJECT NO. _____

SUBJECT SCRUBBER COSTS

IN ORDER TO PROVIDE ACCURATE COST DATA FOR THE DTI SCRUBBER, I ASKED JIM IF LOWER HCl LOADING, IN THE SCRUBBER HE HAD PRICED FOR THE WHEELABRATOR KIDK, WOULD SIGNIFICANTLY REDUCE THE COST OF THE UNIT.

JIM STATED THAT HCl LOADING WOULD NOT SIGNIFICANTLY EFFECT THE COST OF THE SCRUBBER.

A SLIGHTLY DIFFERENT CAUSTIC LOADING WOULD BE REQUIRED, BUT AT A MINIMAL COST DIFFERENCE.

CHAM HILL TELEPHONE CONVERSATION RECORD

CALL TO TOM PARVESSE / METPRO

PHONE NO. (215) 723-6751

DATE _____

CALL FROM AL DAVIS

TIME _____ ☐ AM ☐ PM

MESSAGE TAKEN BY _____

PROJECT NO. _____

SUBJECT SCRUBBER COSTS

IN ORDER TO PROVIDE ACCURATE COST DATA FOR THE PT1 SCRUBBER
I ASKED TOM IF LOWER HCl LOADING, IN THE SCRUBBER -E WED
PRICED FOR THE METPRO CATOX, WOULD SIGNIFILANTLY DECREASE
THE COST OF THE UNIT.

TOM STATED THAT CONCENTRATION HAS LITTLE OR NO
EFFECT ON COST. COST IS DRIVEN ALMOST ENTIRELY
ON STREAM OIZE.

CHM HILL TELEPHONE CONVERSATION RECORD

CALL TO MIKE SWAN / PTI

PHONE NO. (208) 385-0900

CALL FROM AL DAVIS

DATE 6/24/96

TIME _____ ☒ AM ☐ PM

MESSAGE TAKEN BY _____

PROJECT NO. _____

SUBJECT VERIFICATION OF ASSUMPTIONS 5+6 FOR COST BREAKDOWN TABLE

⑤ 100 PANELS 18 CHANGES/YEAR @ \$10/PANEL

MIKE SWAN VERIFIED THAT THIS IS A REASONABLE ASSUMPTION
GIVEN THE CURRENT CONDITIONS AT OUD.

⑥ 15 lbs/PANEL @ \$30.00/TON LANDFILL DISPOSAL COST

MIKE SWAN VERIFIED THAT THIS IS A REASONABLE
ASSUMPTION GIVEN THE CURRENT CONDITIONS AT OUD.



SUBJECT 11120000000000000000

BY _____

Actual Oim costs
for the Catox System

SHEET NO. 1 of 2 DATE _____

PROJECT NO. _____

Monthly
Ave

Feb
1996

Jan
1996

Dec
1995

Nov
1995

Oct
1995

Caustic (25%)
Caustic (15%)
Caustic (10%)
Catalyst
Acid

Spare Parts
Facility Rental
Term Var. Labor

Sub Total

CHAMHILL Labor

Monthly Total

Labor associated with maintenance & scrubber = 52 hrs/month x \$60. = \$3,120.

Catox = 18 hrs/month x \$60. = \$1,080

\$4,200

Yearly maintenance costs associated with Catox system, scrubber, and well field and blower

\$10,296/month x 12 months/year = 123,552

Approximately 10% of total maintenance costs associated with Catox system at OOD =

\$123,552 x 10% = \$12,355

Approximately 75% of total maintenance costs associated with scrubber at OOD =

\$123,552 x 75% = \$92,664

SUBJECT 111000000 AF 15

BY

Actual OIM costs for the Catox system

SHEET NO. 2 of 2 DATE

PROJECT NO.

Approximately 15% of the total maintenance costs associated with well field; blower at OUD

$$123,552 \times 15\% = 18,533$$

APPENDIX L

Actual Costs Incurred During the Demonstration

1 Total Cost of PDT Demonstration	
Actual Labor Costs ¹	\$127,000
Materials and Expenses ²	\$141,000
Total Costs ^{3,4}	\$381,000
2 Percent of Cost that Went Toward Applying the Technology	79%
3a Pre-Treatment Requirements	
(1) Work Plan and Demonstration Plan Development	\$29,300
(2) Regulatory Approval (no approval was required due to back-up remediation system)	N.A.
(3) Mobilization and Preparatory Work	\$5,260
(4) Monitoring, Testing, Sampling	\$5,460
(5) Site Work	Included under Work Plan and Demonstration Plan Development
(6) Surface Water Collection and Control	N.A.
(7) Groundwater Collection and Control	N.A.
(8) Air Pollution/Gas Collection and Control	No direct costs
(9) Solids Collection and Containment	N.A.
(10) Liquids/Sediments/Sludges Collection and Containment	Costs absorbed by other contractors, not included here
(11) Drums/Tanks/Structures/Miscellaneous Demolition/Removal	Costs absorbed by other contractors, not included here
(12) Equipment Installation	\$7,970
(13) Project Management Costs	\$27,020
(14) Other (Travel and Service Center Costs)	\$3,710
3b Treatment Costs	
(1) Sampling and Analysis	\$43,400
(2) Materials (Raw Materials and Equipment)	Included under Operations and Maintenance
(3) Fuel and Utilities (Water, Electricity, Gas, etc.)	\$1,200 (based on 745 hours of uptime)
(4) Operations and Maintenance	\$61,644
(5) Rental Equipment (vehicles, computers, etc.)	N.A.
(6) Facilities (trailers, latrines, etc.,)	Costs incurred under separate contract
(7) Decontamination	Costs incurred by other contractors
(8) Labor	\$17,414
(9a) Other (CH2M HILL Travel and Service Center Costs)	\$9,144
(9b) Other (PTI Project Management and Report Writing Costs)	\$8,900
3c Post Treatment Requirements	
(1) Decontamination and Decommissioning	\$4,899
(2) Disposal (commercial or other)	Cost incurred by other contractors
(3) Site Restoration (e.g. topsoil, landscaping, restoration of roads, etc.)	N.A.
(4) Demobilization	Covered under Decontamination and Decommissioning
(5) Administrative Data Collection and Reporting	\$42,323
(6) Other (Service Center)	\$3,556

Note: Costs current as of April 26, 1996

Costs presented in this table do not include proposal or project management costs.

¹ This includes only CH2M HILL actual labor costs.

² This includes only CH2M HILL materials and expenses.

³ Total costs includes all costs from CH2M HILL, Terra Vac Inc., and PTI.

⁴ PTI Inc. was subcontracted by CH2M HILL to implement and demonstrate the PDT technology on a lump sum basis. Total costs represent actual costs incurred as part of the lump sum agreement. However, PTI incurred approximately \$25,600 more than the lump sum agreement amount for additional equipment modifications and reporting.

Response to Comments for the PDT Technical Memorandum II dated April 17, 1996

—Alexander MacDonald

None.

Comments to PDT Technical Memorandum—Alec Elgal

Comment: This document is dated 12 Mar 96

Response:

Comment: This system was operated and tested in conjunction with the SVE system. For a prospective site the most likely arrangement would be to use either the SVE or this PDT. To make this PDT stand alone it would be worthwhile to know if this system can be operated with charcoal as final filter and thus not depend on an SVE system. On page 20 it is assumed that there will be 95% DRE, which is not competitive with an SVE system. It would be desirable to evaluate the cost of a self-contained system with charcoal where the SVE system is not needed.

Response: A vapor phase activated carbon system would be expected to capture most of the residual organics in the PDT effluent, however, the cost effectiveness of the carbon system would be dependent on the adsorptive nature of the individual compounds present in the gas stream. Charcoal as a final filter would probably not be an efficient means of removing the lighter end compounds such as vinyl chloride, methylene chloride, and freon 113. A target DRE of 99 percent is required for total VOC removal which is a function of the VOC constituents, risk assessment, and BACT requirements. Though it would be interesting, it is not within the scope of this document to include a cost evaluation regarding a vapor phase carbon polish unit for the PDT system.

Comments to PDT Technical Memorandum—Tim Chapman

Comment: Delete "II" from document title

Response: Agree

Executive Summary

Comment: Line 4—Replace "Site S, OU D" with Operable Unit (OU) D Soil Vapor Extraction (SVE) System"

Response: Agree

Comment: Line 29—Revise DRE discussion per comments below as incorporated text.

Response: Agree. Overall TVOC DRE will remain the same because overall total VOC DRE is calculated using mass rate not compound concentration. SVOC DRE was revised using the detection limit for the outlet stream to calculate DRE.

Comment: Lines 33-39—Revise according to modifications in cost estimate. If this estimate shows that PTI is still not cost competitive use text similar to, "The PDT technology was successful at treating contaminated soil vapor. In its current state of development, the PDT is not considered a cost-effective alternative for SVE offgas treatment at McClellan AFB. However, if the system is implemented under high-concentration, low flow-rate conditions, it has the potential to be a cost-effective alternative at McClellan AFB."

Response: Agree. The above text has been incorporated into the memorandum.

Main Text

Comment: Line 3—Add "(AFB)" following "Base's"

Response: Agree

Comment: Line 12—Change "Air Force Base" to "AFB"

Response: Agree

Comment: line 35-36—Delete text following "... (WGA)."

Response: Agree

Comment: Line 65—Change "Air Force Base" to "AFB"

Response: Agree

Comment: Line 38-40—Delete reference to Tech Memo I

Response: No reference found.

Comment: Line 65—"PDT was demonstrated at the Operable Unit (OU) D Soil Vapor Extraction (SVE) system from ?? to ??."

Response: Agree. Sentence has been changed to read, "PDT was demonstrated at the OU D SVE system from November 2, 1995, to January 12, 1996, at McClellan AFB, Sacramento, California."

Comment: Line 72—"The OU D SVE system is part of a full-scale removal action."

Response: Agree. Sentence has been replaced.

Comment: Line 84—Move sentence "A schematic...Figure 3" [should be Figure 4] to appendix or delete.

Response: Agree. Sentence incorporated in new appendix entitled "PDT Cooling Water System Schematic".

Comment: Line 85—Specific figure number.

Response: Agree. Figure defined as Figure # 3.

Comment: Line 89—Delete "II"

Response: Agree

Comment: Lines 91-94—Delete or reword. Make simple statement that slip stream is used for air permitting compliance reasons.

Response: Agree. Text deleted.

Comment: Lines 95-104—Move to after Technology Description

Response: Agree. Moved this section to follow what is currently line 167.

Comment: Line 96—Change "Site S" to "the OU D SVE system"

Response: Agree

Comment: Line 109—Delete "discrete photon"

Response: Agree

Comment: Line 109—Change to "light photons" or "photons of light"

Response: Agree. Changed to "photons of light"

Comment: Line 115-117—This sentence seems to be filler. Delete or tie to text better.

Response: Disagree. The sentence provides pertinent information regarding the reactive nature of intermediates produced during the photolytic destruction of ozone depleting compounds.

Comment: Line 117—Please elaborate that the two are in vapor phase

Response: Agree. The sentence reads as follows. "Vapor phase breakdown products such as acids and reactive intermediates produced in the PTI reactor are reportedly controlled through the use of patented reagent liners.

Comment: Figure 4—Move to appendix or delete

Response: Agree. Moved to new appendix (Appendix B) entitled "PDT cooling water system schematic"

Comment: Line 139-140—Delete sentence. Statement already made.

Response: Agree. Sentence deleted.

Comment: Line 168-170—Move to Experience and Findings section

Response: Agree. Moved these sentences to follow what is currently line 216.

Comment: Lines 274-278—Add text on how overall average DREs are computed; e.g., total of all in vs. all out.

Response: Agree. The text was changed to read:

Individual DRE was calculated as follows:

$$\frac{\sum \text{compound concentration}_{\text{inlet}} - \sum \text{compound concentration}_{\text{outlet}}}{\sum \text{compound concentration}_{\text{inlet}}}$$

Overall average total VOC DRE was calculated using the following formulas:

$$\frac{\sum \text{mass rate}_{\text{inlet}} - \sum \text{mass rate}_{\text{outlet}}}{\sum \text{mass rate}_{\text{inlet}}}$$

Using the above formula, average overall DRE was calculated as follows:

$$\frac{\sum DRE}{\text{Total \# DREs}}$$

Comment: Line 81 [should be 281]—Delete reference to figures. Summarize results succinctly in tables (preferably one) instead.

Response: Agree. Changed text to read ... are presented in Tables 1,2,3 and 4. A graphical representation of the data is available in Tables D-1 and D-2 in Appendix D.

Comment: Figure 6—Move to appendix

Response: Agree. Renamed Figure 6 to Figure E-2 and moved to Appendix E.

Comment: Figure 7—Move to appendix

Response: Agree. Renamed Figure 7 to Figure E-4 and moved to Appendix E.

Comment: Line 303—Delete references to figures. Summarize results succinctly in table.

Response: Agree. The tables also provide data regarding influent concentrations of the individual contaminants present in the Site S gas stream. This data when coupled with the DRE data can be used to theorize the effectiveness of PDT at sites with mixed contamination.

Comment: Line 303-304—Delete sentence

Response: Agree.

Comment: Lines 304-307—This doesn't seem to "buy" anything. Move to appendix or delete.

Response: Agree. Deleted sentences on line 304 through 308.

Comment: Line 325—PTI did not use "pretreatment" of offgas. If you mean the additional knock-out pot then state that, otherwise delete.

Response: Agree. Delete sentence starting on line 324.

Comment: Figure 8—Move to appendix

Response: Agree. Changed Figure 8 to Figure E-1 and moved to Appendix E.

Comment: Figure 9—Move to appendix

Response: Agree. Changed Figure 9 to Figure E-3 and moved to Appendix E.

Comment: General 1—Table should have all DREs in it. Could be multiple tables for varying process conditions.

Response: Agree. Have added four tables which provide DRE results based on concentration and provides and overall DRE for total VOCs based on mass rate.

Comment General 2:- Need to present an overall DRE. Since the total VOC component is measured at much less than the TO-12 (apparently), it would be worthwhile to discuss what the overall DRE is. You can base it on the Title 3 list or by other methods, but it should be included.

Response: Agree. Have added a sentence to line 323 to read "Three samples were collected and analyzed for VOCs and total nonmethane organic compounds (TNMOC). Because total VOCs are reported as ppm and TNMOC is reported as ppm as carbon, concentrations obtained for total VOCs and TNMOC were calculated as mass rate to obtain equivalent carbon concentrations. Based on the total VOC and TNMOC concentrations, it is apparent that total VOCs comprise approximately 95 percent of the TNMOC.

Comment: Line 440—Delete ", at Site S."

Response: Agree

Comment: Lines 444-446—Delete reference to SDPT substance. Comparing these two substances without serious analysis is too much for this report.

Response: Agree. Deleted lines 430 through 460 replaced text with originally on lines 260 through 268.

Comment: Line 448-460—What does this "buy." Elaborate or delete. Basically, I'd prefer to delete it since only a minor amount was observed.

Response: Agree. Text deleted. Replaced the word "discussion" on line 462 with the word "information".

Comment: Lines 467-469—Elaborate on what compounds you would scrub. Do you need an ozone decomposer or just an acid gas scrubber.

Response: Agree. Replaced the word "gaseous" with "the acidic" on line 468.

Comment: Lines 469-474—This is misleading. AB 2588, etc., risk assessments are required in California. BACTs, etc., are local implementations and change based upon SIPs. Be specific to McClellan and talk about what would be required to do here only. End with every site will have to do its own regulatory evaluation.

Response: Agree. Lines 470 to 474 changed to read, "The new source review rule will require BACT and TBACT which is a local air district requirement. "

Comment: Lines 486-487—Refer to [new] table showing total influent concentrations, not just VOCs.

Response: As discussed in the general comments, the VOC concentration comprises approximately 95 percent of the TNMOC concentration, therefore TNMOC concentrations will not be added to the total influent concentration.

Comment: Line 489—Mass removal rate restates what DRE means so delete first part of sentence

Response: Agree. In this context mass removal rate refers to mass of contaminant removed from soil. For clarity we have replaced the word "removal" with "loading"

Comment: Table 1—See Appendix J comments

Comment: Table 2—See Appendix J comments

Comment: Lines 508-553—Shorten this discussion to one or two paragraphs.

Response: Agree. Much of the text has been deleted particularly that which pertained to the pros and cons of the concentrator technology.

Comment: Lines 557-559—Reword this sentence. If you are agreeing with the PTI statement then reword to say CH2M HILL agrees with your text about economic viability.

Response: Agree. Text from lines 555 through 556 has been rewritten and "CH2M HILL agrees that" has been deleted.

Comment: Lines 559-566—Delete here, you can include it in one or two sentence summary.

Response: Agree. The Conclusions and Recommendations section now reads as follows.

Once the mechanical difficulties in the cooling system were overcome, the PDT reactor was successful in the treatment of the OU D process gas. The average DRE during the final six

weeks of operation was 92.1%. During the demonstration the reactor efficiency was not affected by deposition of the tarry substance associated with previous demonstrations at Site S. There are several reasons for the decrease in deposition, PTI's current reactor was designed to promote deposition of the substance in noncritical areas within the reactor. Also, the overall concentration of the gas stream has decreased threefold since PTI's last demonstration. PTI believes their unit is best equipped to treat low flow, high concentration scenarios. PTI plans to study the economic benefits attained through the installation of a concentration upstream of the PDT reactor

PTI has improved their reactor design over the past year; however, further design modifications could improve the system's effectiveness. These improvements relate specifically to reactor ergonomics, such as ease of maintenance and cleanup. The tasks of lamp and liner replacement remain labor-intensive. The time required for these tasks could be significantly reduced through improvements in the reactor sealing mechanism and in the access route to the reactor internals. A possible solution would be allowing access to the reactor internals from the side as opposed to the top. Easy cleaning of reactor surfaces and debris removal from the floor of the reactor might be achieved through the design of replaceable internal panels.

Comment: Lines 576-587—Delete section.

Response: Agree

Comment: Line 595—Delete "II"

Response: Agree

Comment: Appendix B—Add some text stating that the schedule was followed or how actuals deviated from planned.

Response: Agree. Have added a sentence to the bottom of Table C-1 which states how the actual number of samples collected deviated from the planned number of samples collected.

Appendix C [now Appendix D]

Comment: Include process parameter table like in SDPT tech memo.

Response: Agree. Process parameter table inserted.

Appendix J [now Appendix K]

Comment: Need more detailed backup for assumptions.

Response: Agree. Additions include those listed below and further explanatory text.

Comment: Need to account for lower run time for Catox unit than estimated for PTI system. I estimate Catox system has at best an 80% uptime.

Response: Disagree. The Site S Catox is not typical, based on vendor expectations it is appropriate to assume similar uptimes for a Catox and a PDT reactor.

Comment: Need to include NO_x reduction credits in total cost. Also, discuss ozone emissions if credits will be needed at McClellan.

Response: Agree. NO_x reduction credits are incorporated into the Appendix K catox operations costs. NO_x emissions will be based on actual NO_x loadings observed during source tests at Site S. The cost of NO_x credits will be based on information provided by Tim Chapman/BDM.

PTI Cost Summary

Comment: PTI claims they can build a bigger unit. Base cost estimate around single 250 scfm unit of 2 or 3 smaller units. The current extrapolation is not acceptable.

Response: Due to PTI's recent experiments involving the concentrator they do not feel it is accurate to estimate the cost of the PDT unit without a concentrator on-line. PTI and CH2M HILL do not see a benefit in recalculating the PTI portion of the cost estimate using a new system configuration.

Comment: Assumption 5—Document conversations with PTI that are included here

Response: Agree. Documentation referenced in Appendix K text.

Appendix K [now Appendix L]

Table 1

Comment: Move to Appendix J [now K]

Response: Agree

Comment: Assumptions 1, 2, and 3 not valid, this type of system is commercially available. Use current manufacturer information. Can extrapolate installation costs for experience. Remember to adjust numbers for inflation.

Response: Agree. Budgetary catox cost estimates have been requested from several vendors. The Appendix L cost analysis now presents an average cost from the vendors estimates and previous engineer's estimate. The vendor pricing is current and therefore the addition of inflation to the estimate is not required.

Comment: Assumption 4—Base this on actual experience, accounting for inflation. Need to document basis for labor.

Response: Agree. The labor costs have been reexamined with input from vendors and CH2M HILL experience, however, inflation will not be included since labor (wage) costs are reported based on 1996 expected rates.

Table 2

Comment: Delete, should be Appendix J information

Response: Agree

Comment: Actual Costs Incurred During Demonstration not in requested format.

Response: Agree. Table upgraded to requested format.

Comments to PDT Technical Memorandum—Ronald Lewis

Comment: A glossary of abbreviations should be added at the beginning of the report.

Response: Agree. A list of Acronyms and Abbreviations has been compiled.

Comment: The demonstration objectives should include the evaluation of the operability and reliability of the technology. This evaluation's focus should not be solely on how the technology performed during the demonstration but also on how the technology would perform in "normal" operation.

Response: Agree. The following text is included in the Future Implementation Costs Discussion. "Based on manufacturer supplied data the lamps are rated for one year of service. Other process equipment such as pumps, blowers and ballasts are expected to provide a normal service life of 3 years or longer. Under the current conditions at Site S the PDT system would be expected to provide 90% uptime."

Comment: Lines 144 and 145 mention that, "The reagent panel is replaced when reaction byproducts such as HCl and chlorine exceed emission limits." How will this condition be detected during normal operation?

Response: Agree. The following text has been added after line 147 in the text. During start up of the system at a given site HCl and chlorine levels in the effluent will be monitored frequently in order to provide an indication of the frequency of required liner replacement. As the operation of the system becomes better known less sampling will become required. It is theorized that other indicators such as a decrease in DRE may also provide adequate justification for replacement. PTI hopes to employ a UTI monitoring device to provide

efficient, real time, monitoring for their system. A discussion regarding the accuracy of the UTI monitor is presented in Appendix F.

Comment: Lines 356-366 discuss how testing by EPA Method 26A/300.0 show increasing HCl concentrations. I assume this type of testing would not be performed for a "normal" operating unit. Did the UTI detector indicate that the liners were becoming saturated with HCl?

Response: A specific reference to this comment is not included in the main test. However, text added in Appendix F describes that the UTI does not provide an accurate measure of HCl levels, therefore, initial testing using EPA Method 26A/300.0 would be required in order to insure acid levels were controlled.

Comment: Lines 365 and 366. Why was no further acid testing performed after liner replacement?

Response: All scoped HCl sampling had been collected prior to the liner change-out. This text has been added to line 366.

Comment: Figure 6-9. The presentation of information in these figures is somewhat confusing. It would be helpful if the compounds that are in all the figures were listed first and in the same order. This would make it easier to compare the results of one method versus the other.

Response: Agree. Explanatory text on the figures has been improved. Note, per comments by Tim Chapman/BDM, the figures have been moved to Appendix E and Figures E-1, E-2, E-3, and E-4, and Tables 1 through 4 have replaced them in the main text.

Comment: Also, the distinction between the two types of data listed in the legend needs clarification. The first appears clear, "Average of all samples collected." The second is ambiguous. Is it the average after a certain date? Is it the average of multiple samples taken on the same date? What is the significance of the date?

Response: Agree. The second average is the average DRE for all samples collect between December 1, 1995, and the conclusion of the demonstration. Text has been added to the legend(s) to clarify this point. The significance December 1, 1995 is that it is the first sample date following the installation of the new cooling plenums. Please see the discussion under VOC Destruction Removal Efficiency for further explanation.

Comment: Lines 333-335. The discussion of the UTI results is much too brief. How did its results compare to the other analytical methods used? The trends shown by the results of this unit could be very informative since there are many more data points. Since this unit is in-line, its results are not subject to variations in sampling technique, shipping, handling, and analysis. Also, this device is what the operators of the PDT unit will depend on during normal operation. Was it successful for this purpose?

Response: Further analysis of the UTI now appears in Appendix F. This report being specifically designed to study the effectiveness of the system using established analytical techniques. For this reason, the UTI did not receive the same level of attention as that compiled through approved techniques. To complete a detailed evaluation of the UTI compared to currently approved analytical methods, a UTI evaluation objective be added to future demonstrations.

Comment: Appendices. The tables and lines of text in the appendices should be consistently numbered to make referencing comments easier. Line 27 of Appendix C refers to November 29. I think this date must be an error. Based on the adjoining text, the date must be between November 21 and 27.

Response: Agree. Date has been changed to November 22.

Comment: Appendix D. When calculating the DREs, the authors of the memorandum apparently used a value of "zero" for the outlet concentration when the results were "not detected." It is standard practice to use the detection limit in these instances and to report the DRE as being greater than the calculated number.

Response: Agree. The DREs have been recalculated and all tables and figures have been updated.

Comment: Tables D-1 and D-3 should present similar information, the only difference being that one is sorted by sample and the other by compound. Table D-1 shows too much information and Table D-3 shows too little. I think the minimum would be:

- Sample number
- Date
- Compound
- Inlet concentration
- Outlet concentration
- DRE

Adding the flow rate would be all right but the mass rate and mass removed information is overkill. This information clutters the table and adds little. Overall (total for all compounds) mass removal rates would be of interest, but this would be better shown in a separate table.

Response: Disagree. The tables present the required data for a complete appendix. Note, per comments by Tim Chapman/BDM, new, less cumbersome tables have been placed in the main text as Tables 1, 2, 3, and 4.

Comment: Appendix E. The print quality of the tables is poor (a copy of a fax?). The two tables appear to give redundant information. Are the concentrations presented "corrected" or "uncorrected?" Figures plotting the data would be useful, especially inlet concentrations

versus the date and DRE versus the date. Also, it would be useful to show some comparison of this data to that obtained by Method 8010/8020 and Method TO-14.

Response: Agree. Better quality tables and a cursory comparison has been added.

Comment: Appendix F. [now Appendix G] The unnumbered table (CIPDTIS XLS) has "inlet" in the title banner but "outlet" in the column heading. Which is correct? This table and the ones similar to it should mention the test method that is being reported. The dates for the inlet and outlet samples that appear in the title banner of the SVOC tables are different. If the inlet and outlet samples were not collected at the same time, it is inappropriate to use this data in a DRE calculation.

Response: Agree. "Outlet" removed from column heading. Approximately 4 hours is required when collecting samples using the EPA Method 5. Therefore inlet and outlet sampling pairs may often be completed the day following the initial test. Based on several past samples it is shown that inlet soil gas contaminant loading rates remain constant over this relatively short time period.

Comment: Lines 343-352 discuss the acetone results that are presented in Appendix F but the table in the appendix does not support the discussion. Where is the comparison of results of TO-14 and NIOSH 1300? Where is the comparison of the DREs for data from either method?

Response: The information in lines 343 through 352 was changed to read, "Four acetone samples were collected and analyzed according to NIOSH Method 1300. Based on two sample events, the average DRE for acetone was 95.8 percent. Acetone results are provided in Appendix G, Table G-2.

Comment: Appendix G.[now Appendix H]. The text could use some help in grammar and spelling.

Response: Agree

Comment: The NO_x calculations seem suspect to me. The text mentions dilution to one liter for the first sampling event. If this were the case, wouldn't $S_c = S_m$? The second page of emission calculations mentions NO_3 but the first page does not. Is the analysis for NO_3 or NO_2 ? If the analysis is for NO_3 and the results are later corrected for NO_2 , shouldn't the molecular weight of NO_3 (62.01) appear in the calculation rather than that of nitrogen (14.01)?

Response: The calculations are correct based on the following convention; the results obtained from the ion chromatography analysis are Nitrate (NO_3) reported as Nitrogen (N).

Comment: Lines 449 and 450. Revise, "Although phosgene was not detected, because of potentially defective Draeger tubes,..." to "Although phosgene was not detected, potentially because of defective Draeger tubes,..."

Response: Agree. Text from lines 430 through 460 have been revised.

Comment: Cost analysis. I am highly suspicious of this cost analysis. It appears to be biased toward the Catox unit. CH2M HILL would certainly be inclined to be biased toward their own technology. I suspect that there would be substantial improvements in the "efficiency" of building and operating PDT units if ten units were purchased for the hypothetical cost analysis. I also suspect that there have been substantial improvements in the efficiency of building and operating a Catox unit. My impression is that the cost estimate took into account these improvements for the Catox unit but did not do so for PDT. Therefore, the costs represent a worst-case for the PDT and a best-case for Catox. It also appears like the costs used in the PDT were quite thorough. However, the costs for the Catox system seemed overly simplified. Most Catox [costs] were prorated from another report and lack the same level of detail as given to PDT. The most thorough analysis of anything presented in the report would appear to be the "Future Implementation Costs Discussion" on page 22. This analysis seemed like an effort by the author to dismiss future improvements in the PDT that would allow it to better compete with their own technology.

Response: Further verification regarding the cost analysis has been included in the report. Many of these efforts are described above in the latter portion of comments submitted by Tim Chapman/BDM.

Response to Comments for the PDT Technical Memorandum II dated May 22, 1996

PDT - Tim Chapman

Reviewer Response/Clarification (Lines 115 - 117): This sentence provides information on how ozone is depleted within the upper atmosphere. It does not illustrate how the PDT works and it implies that Cl radicals will deplete ozone if emitted from the unit. Either change the discussion to discuss more pertinent scenarios or remove it altogether.

Response: Agree. Deleted this sentence.

Reviewer Response/Clarification (Referring to General 2): The added text is awkward. Revise section to be concise. Suggest adding text stating that VOCs comprise approximately 95 percent of the VOCs detected.

Response: Agree. The text has been changed to read, "Approximately 40 VOCs are included in the Method TO-14 compound list which includes halogenated, nonhalogenated, and aromatic compounds. Method TO-12 reports the concentration of total nonmethane organic carbon (TNMOC) which only detects compounds with carbon-hydrogen bonds. Three samples were collected and analyzed for VOCs and TNMOC. Concentrations obtained for total VOCs and TNMOC were calculated as mass rate to obtain equivalent carbon concentrations between the two sets of results. Because approximately 40 percent of the total mass reported from Method TO-14 is from chlorine, the mass rate for TO-14 was normalized to account for only carbon containing compounds.

A mass rate of 0.07 lbs/hr was reported by Method TO-14 and a mass rate of 0.12 lbs/hr was reported by method TO-12 for the sample collected at the inlet on November 30, 1995. A mass rate of 0.05 lbs/hr was reported by Method TO-14 and a mass rate of 0.09 lbs/hr was reported by method TO-12 for the sample collected at the inlet on December 7, 1995. A mass rate of 0.07 lbs/hr was reported by Method TO-14 and a mass rate of 0.11 lbs/hr was reported by method TO-12 for the sample collected at the inlet on December 14, 1995. The mass rates reported by Method TO-12 are approximately 55 to 65 percent greater than the mass rates reported by Method TO-14. This difference is most likely attributed to the detection of long-chain hydrocarbons such as decane and nonane by Method TO-12 that are not detected by Method TO-14."

Reviewer Response/Clarification (Lines 274-278): The revised text does not fully reflect the reviewer's understanding of the resolution agreed to during the telecon to discuss comments. The reviewer understood that DREs would be based upon mass calculations, but that corresponding concentration values would be presented in tables. In the response the third formula and supporting text is not useful. Average DREs can be calculated using the second formula.

Response: Agree. The text was changed to read:

Average DREs were computed for VOCs, semivolatile organic compounds, acetone, and total non-methane organic compounds. DREs for individual VOCs from EPA Method TO-14 and modified EPA Method 8010/8020 are presented in Tables 1 through 4. Tables 1 and 2 present average influent concentrations and DREs observed throughout the demonstration. Tables 3 and 4 present average influent concentrations and DREs observed

after the new plenums were installed. Installation of the new cooling plenums was completed on December 1, 1995. Individual VOC DREs were calculated as follows:

$$\frac{\sum \text{compound concentration}_{(inlet)} - \sum \text{compound concentration}_{(outlet)}}{\sum \text{compound concentration}_{(inlet)}}$$

Tables 1 through 4 also present the overall average VOC DRE for each treatment period. The overall average VOC DRE for each treatment alternative was calculated using the mass rate for the inlet and outlet gas streams for each individual compound as follows:

$$\frac{\sum \text{individual compound mass rate}_{(inlet)} - \sum \text{individual compound mass rate}_{(outlet)}}{\sum \text{individual mass rate}_{(inlet)}}$$

Inlet and outlet samples analyzed by GC Method 8010/8020 on December 7 showed a negative DRE for methylene chloride. This data point was considered an outlier and was eliminated from the data set, because no identifiable reason was determined for the high concentration of methylene chloride in the outlet stream. The reader is referred to Appendix E for more detail."

Reviewer Response/Clarification (Line 281): Delete reference to graphical representation in main body of text. Include discussion in appropriate Appendix.

Response: Agree. Text relating to tables and figures are addressed in the previous comment.

Reviewer Response/Clarification: (Referring to line 469 - 474). Delete this text. Add sentence similar to that of 400 - 402 to end of 397. For example, "For full-scale, implementation at McClellan AFB or any other sites, a compliance evaluation with local air emissions regulations will be required." This type of unit would be required to comply with BACT for HAPs/TACs and potentially with RACTs for nonattainment pollutants.

Response. Agree. Changed text to read. "For full-scale implementation at McClellan AFB or any other sites, a compliance evaluation with local air emissions regulations will be required. The PDT unit would be required to comply with best available control technology (BACT) for hazardous air pollutants/toxic air contaminants (HAPs/TACs) and potentially with reasonable available control technologies (RACTs) for nonattainment pollutants. (now lines 388 - 393).

Reviewer Response/Clarification: (Referring to line 489). How does the mass of contaminant removed from the soil relate to the cost estimate? Since costs are not being computed on a pound removed basis, only influent and DRE should be required. Explain why this is needed or remove.

Response: Agree. Changed text to read, "A flow throughput of 250 scfm."

Reviewer Response/Clarification (Referring to line 559 - 566). Please change as follows: "Once the mechanic difficulties in the cooling system were overcome, the PDT reactor...."

Response: Agree. Changed text to read, "Once the mechanical difficulties in the cooling system were overcome, the PDT reactor was successful in the treatment of the OU D process gas. The average DRE for VOCs during the final six weeks of operation was 92.1 percent. During the demonstration, the reactor efficiency was not affected by deposition of the tarry substance associated with previous demonstrations at OU D. The reasons for the decrease in deposition include redesign of the reactor and a lower concentration gas stream at OU D. PTI believes their unit is best equipped to treat low flow, high concentration scenarios. PTI plans to study the economic benefits attained through the installation of a concentrator upstream of the PDT reactor.

Reviewer Response/Clarification: The 80% estimate was not based upon Site S experience. It is NOT reasonable to use a 99% uptime. At best, you should expect no greater than a 95% uptime even for a very reliable unit. The backup for both need to be provided. You should not use manufacturer's expectations for this unless absolutely necessary.

Response: Agree. The Estimated Cost Breakdown for the Full-Scale Unit provided a process/equipment uptime of approximately 90 percent. However, based on actual uptimes for the Catox unit during November and December of the demonstration, the actual uptime was 86 percent. This can be verified from the process logs that were maintained at Site S during the demonstration. Therefore the text on lines 482/483 was changed to read "85 percent process/equipment uptime (average of 20 hours/day) during normal operations.

Reviewer Response/Clarification: While the reviewer does not necessarily agree with using 10-24 scfm units, please document the conversation with PTI in the appendix backup.

Response: Agree. The documentation of the conversation with PTI will be included in the document.

Reviewer Response/Clarification: (Assumptions 1,2,3) Remove engineer's estimate from document. Use professional judgment on the quotes received and their applicability to this estimate. The adjustment for inflation is only required for numbers extrapolated from past years. Not including "interest calculations" is assumed to mean that capitol costs will not be amortized. Amortization is only required if equipment has different life-expectancies.

Response: Disagree. This cost estimate only includes quotes from two different vendors, however there are approximately 50 different vendors of oxidation systems. Each vendor uses a different catalyst, fluidizing bed, etc., and each vendor's quote will increase a minimum of 35 percent because of the wide variation in terms of there standard package. Because the quotes obtained are not for the same system capacity, they are not directly comparable and should not be averaged.

The engineers estimate is the most accurate way to estimate costs and is the documented form of professional judgment. The estimate provides the engineers basis to come to a conclusion. Because of market fluctuations and differences between vendor quotes, a reasonable (optimum) cost was assumed. Therefore, the engineers estimate should not be removed because it takes into account all variables, and the "6/10" rule scales all costs appropriately.

For comparison purposes, each vendor quote for the 250 cfm unit will be presented and an average cost calculated. The engineers estimate will be included as a baseline reference to indicate that the vendor quotes are reasonable and within the engineers estimate.

We agree that the capital costs are not amortized because different life expectancies for the equipment are expected.

Reviewer Response/Clarification: (Assumptions 4). No basis is provided to show how annual maintenance costs are actually observed to be 10% of equipment capital costs. It is not apparent that this would be directly scaleable from experience gained at Site S. Need to provide more detailed basis for this assumption for review and include more information in Appendix.

Response: Agree. The rule of thumb for maintenance costs is 10 percent of the equipment capital costs. This percentage is obtained from the Chemical Engineers Handbook, (Section 25, Perry & Chilton, Fifth Edition).

The actual operation and maintenance cost for the Catox/Pass system at OUD will be calculated for the last 5 months of operation for the 1200 scfm unit. The operation and maintenance associated with the 250 cfm unit is expected to be the same as that for the 1,200 cfm unit and a scale-down factor is not used.

New Appendix J Comments - Tim Chapman

Comment (Line J-1 #1): Delete engineers estimate.

Response: See above comment.

Comment (Line J-1 #2): Maintenance cost of 10% of capital cost is not backed up within report. I still do not agree that a flag 10% of capital is reasonable. Need to provide backup, reference, etc. Or change to actual experience (with supporting backup and inflation). Comparison of O &M supply costs from other Catox systems do not support this assumption.

Response: See above comment.

Comment (Line J-1 #3): Has this number been adjusted for inflation. It is reasonable to do a direct extrapolation of catalyst replacement from a 1200 scfm unit to a 250 scfm unit? If so, the document.

Response: This number reported is based on a combination of several items (process logs, supervisors, subcontractors, vendors, etc.). Attrition of catalyst is not what vendors have typically seen, but it was what was experienced with the SVE system at OU D. Only this site has experienced the problem related to the depletion of oxygen. Therefore, it is expected that the costs can be extrapolated downward accurately.

Comment (Line J-1 #4): Has this number been adjusted for inflation. Is it reasonable to do a direct extrapolation of natural gas use from a 1200 scfm unit to a 250 scfm unit? If so, then document. Other catox systems at McClellan would not support a direct scale down.

Response: If concentrations remain the same, it will be very close to a direct extrapolation because the actual gas consumption will remain the same.

Comment (Line J-1 #5): Has this number been adjusted for inflation. Is it reasonable to do a direct extrapolation of electrical use from a 1200 scfm unit to a 250 scfm unit? If so, then document. Actual electrical use for other systems are much higher than estimate using direct scale down.

Response: If concentrations remain the same, it will be very close to a direct extrapolation because the actual electrical use will remain the same. The instrumentation and control systems, ID fan, and additional fans (≈ 20 hp) would require the same amount of energy.

Comment (Line J-1 #6): Has this number been adjusted for inflation. Is it reasonable to do a direct extrapolation of expendables from a 1200 scfm unit to a 250 scfm unit? If so, document. Typo in \$0.40 before parentheses should be removed. Expendables usage at other McClellan Catox systems would not support direct scale down.

Response: Based on our experience, the cost of expendables will not vary if the concentrations remain the same. However, we do not have a catox unit of 250 scfm that we can compare the cost to. Also, typo in "0.40" before parentheses were removed.

Comment Table J-1: Why are 12 scfm unit costs shown? Would be more appropriate to show a 24 scfm cost and then the total 240 scfm cost or just the 240 scfm cost. Delete 12 scfm cost column. If information is needed elsewhere, then move to text or text in backup.

Response: Agree. The costs for a 12 cfm unit has been removed from the cost breakdown. This has been replaced with the costs for a 24 cfm unit. It is expected that the costs associated with a 24 cfm unit are very comparable to the 12 cfm unit. The costs for the 240 cfm unit are then directly extrapolated from the 24 cfm unit.

Comment Table J-1 Reactor cost and assumption 9: Basis for 1.5 factor not given. Need supporting information.

Response: This assumption was agreed upon with PTI. This conversation with PTI will be documented.

Comment Table J-1 scrubber: Information on scrubber not included. What size would be needed? What type of scrubber, etc.?

Response: The scrubber would need to be sized to treat the offgas to certain requirements. This is an average cost for a scrubber that could handle a 250 scfm gas flow with 99 percent acid removal. Using these assumptions, quotes from vendors are included in the cost estimate.

Comment Table J-1 Controls: How was number arrived at? Need basis.

Response: The \$4,000 for the 12 cfm unit was an actual value provided by Mike Swan/PTI. Therefore, the \$12,000 is a scale-up of the \$4,000 which was approved by PTI. Documentation of the telecon will be provided.

Comment Table J-1 Power: Basis for 1.5 needed.

Response: See above comment.

Comment Table J-1 Power: Adjust basis for power on expected up time. In previous section it was stated the system would have a 90 percent uptime. The 8088-h figure does not agree with this.

Response: The 8088 hours reported is approximately 90 percent. Number of hours has been revised to 7,000 hours (approximately 85 percent uptime).

Comment J-1 Consumables: Is 18 changes per year accurate? The experience of the demo does not support this number. Also, with increased liner size, the number of replacements should be lower.

Response: The number of changes per year (18) was based on the actual number replaced during the demonstration and has been agreed to by PTI. The number of replacements should not be lower because the reactor has only been enlarged by a factor of 1.5, therefore this counteracts the larger panels. Documentation of the discussion with PTI is included in the cost estimate.

Comment Table J-1 Consumables. Basis for 1.5 scale-up need. Is the 300 lamp/reactor correct? Previously PTI systems had fewer lamps. Is expected service life still 10,000 hours? If so, this would result in fewer change outs than assuming an 8,000-hour life.

Response: Yes, this is correct. The 10,000 hour versus 8,000-hr lamp life is within the accuracy of the estimate.

Comment Table J-1 Labor and assumption 16: By saying the labor is 10 times greater than a 12 scfm reactor, are you assuming that there will be less overall labor for a 24 scfm unit change out? I would expect significant improvements in maintainability with a purchased unit. A more detailed basis is needed for this assumption.

Response: Yes, the labor assumption was based on PTI's understanding. Yes, there would be less overall labor for a 24scfm unit change-out. This assumption supports the time expectation. Documentation of the discussion with PTI is included in the cost estimate.

Comment PTI Power Consumption: Please explain that this is for a 12 scfm unit. Also, this consumption does not support the scale up very well. Suggest replacing with an estimated consumption for a 24 scfm unit.

Response: The power consumption is based on the demonstration unit. The cost breakdown for a 24 cfm unit has been included, and the extrapolation for the 240 cfm unit revised.

Comment NOx Backup: NOx credits are purchased/calculated on a quarterly basis. The factor of 1.3 must be applied quarterly. Since NOx production is a factor of natural gas usage in the preheater for the Catox system, be sure that direct scaling is appropriate (see previous comment). Other Catox systems at McClellan would not support a direct scaling (e.g., other units would not use as much NOx credit per scfm). Also need to factor in run time for Catox system (do not assume a 24-hr/365 day usage).

Response: Agree. The cost estimate has been revised to present the NOx credits on a quarterly basis.

Comment Table J-1: Need to add support for not including ROC/TVH emission credit usage for Catox system & PTI. If They are similar, then so state (but if differing DREs are used, then please consider).

Response: Because we are using natural gas, we can assume that very little methane is being produced. It is expected that the DRE for ROC would be very similar to TNMOC therefore, ROC/TVH emission credit for the Catox Unit and PTI are not included.

PDT - Ron Lewis

Reviewer Response/Clarification: Delete reference to Site S, refer to as OU SVE system. What is basis for 90 percent uptime for PTI system?

Comment: Agree. The text was changed to read "Based on manufacturer supplied data the lamps are rated for one year of service. Other process equipment such as pumps, blowers, and ballasts are expected to provide a normal service life of 3 years or longer. Under the current conditions at the OU D SVE system the PDT system would be expected to provide 90 percent uptime."

The 90 percent uptime for the PDT system is based on a summation of required downtime as agreed to by PTI.

Reviewer Response/Clarification: Delete Tables D-3 and D-5 or reformat to include the same format as Table D-1 and D-4.

Response: Agree. Tables D-3 and D-5 were deleted from Appendix D.

Reviewer Response/Clarification: Was test method added to tables as requested?

Response: Yes, all semivolatile organic compound tables were revised to include the method number and all references to inlet and outlet stream are consistent.

Reviewer Response/Clarification: See comment on average DRE. The 95.8 appears to be the average of the 2 DREs not the average DRE.

Response: The previous response to this comment showed that the text was revised to discuss only the acetone results obtained by NIOSH Method 1300. The discussion regarding acetone results obtained from Method TO-14 will not be used and was deleted from the text. A footnote was added to tables and figures presenting Method TO-14 results indicating that "Method TO-14 is not a recommended method for acetone analysis in a mixed gas stream. The reader is referred to Appendix F, Table F-2 for acetone results obtained by NIOSH Method 1300." The text on line 345 discussing acetone DREs pertains only to the DREs obtained by NIOSH Method 1300. It is not the average of DREs obtained by Method TO-14 and NIOSH Method 1300.

General Question from Ron Lewis: Have all tables been labeled?

Response: Yes.

PDT Response to Comments #3, July 3, 1996

Comment #	Comment	Response
PDI Cost Estimate		
1	The maintenance and supervision costs in Table 5 only include the scrubber portion. The catox maintenance should also be included. In that, annual costs should be \$105,000 (\$12,355 + \$92,644). However, if the number presented uses a scale down factor, please indicate in Appendix K discussion and provide backup. The title of Appendix L indicates that it should only contain what is now Table K-2.	Agree. The maintenance and supervision costs in Table 5 were revised to read \$105,000. This number does not include a scale down factor, therefore backup was not included.
2		Agree. As indicated below the Appendixes were revised and information is provided in only two appendixes.
3	Redo appendixes K, L, and M. Suggest two appendixes. One that contains all the cost estimate backup information and one that contains only the costs incurred during the demonstration. Name these appendixes accordingly, i.e., cost/backup information and costs incurred during demonstration.	Agree. The cost estimate was revised and all cost estimate/backup information is presented in one appendix and the table for the actual costs incurred during the demonstration is presented in another appendix with the same title.
4	Appendix M, labor, operating labor, the \$16,400/yr for the labor and its footnoted assumption should have basis stated in backup (e.g., based on PTI estimate, based on experience during demonstration, etc.). May need additional calc sheet or telecon.	The assumption 8 in appendix M was revised to read "16 hours/panel changeout + 40 hours/lamp changeout @ \$50/hour (includes supervisory time) based on experience during the demonstration.
PDT Main Text		
5	Lines 149-157 and 158-179. The second block of text restates what had just been said. Move text lines 159-171 up to line 149 section and condense further. Change "Site S" references to "OU D SVE system" throughout.	Agree. Text was originally revised correctly however, errors in transmission indicated text had not been revised. All references to "Site S" were revised to read "OU D SVE system".
6	Lines 248-250. Equation did not print out correctly. Also line 247 lead in appears to be missing text.	Equation and text did not transmit correctly. Text was revised correctly prior to transmission.
7	Table 1 and 2. Need to add footnote like SDPT document for Acetone results and use NIOSH 1300 results in lieu of TO-14.	Agree. Tables 1 and 2 were revised with the same notes as those contained in the SDPT tables.
8	Line 431-432. Delete RACT discussion for this technology.	Agree. The sentence was revised to read "The PDT unit would be required to comply with best available control technology (BACT) for hazardous air pollutants/toxic air contaminants (HAPs/TACs).
9	Tables 5 and 6 ignored since revisions were faxed.	
10	Line 470-471. This should be deleted as the liquid is from a knock-out pot that will be identical to that of the SVE system.	Agree. This bullet was deleted from the text.
11	Line 474-475. Rephrase to state that supplemental acid gas treatment is not being included and could impact not significantly impact to overall cost.	Agree. This text was deleted because information about the scrubber was included in the cost estimate and its impact on the overall cost of treatment can be evaluated.
12	Line 487. "D" was omitted from "OU D SVE system."	Agree. The text was revised to read OU D SVE system.

13 Lines 494-499 is the PTI cost estimate included in the report. If so, reference; if not, Agree. The text was revised to read, "To best predict
rephrase slightly to indicate it is not. future costs associated with full-scale PDT operations,
PTI has prepared a cost estimate that includes the
addition of a concentration, this cost estimate is not
included in this document.

PDT Executive Summary

14 Line 30. Change Site S to OU D. Agree. Text was revised to read OU D.